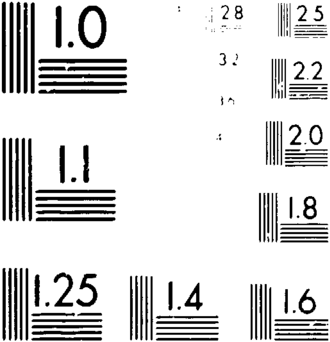

MICROCOPY RESOLUTION TEST CHART

CONSULTING GES.M.B.H.

6. U N I D O - W O R K S H O P

ON FERTILIZER PLANT MAINTENANCE

19. September - 4. November 1983

13482
(1 of 2)

D O C U M E N T A T I O N - PART I

chemserv
CONSULTING GES.M.B.H.

Empfänger	Unser Zeichen*)	Blatt	Tag
UNIDO	LCS/He/st	1	1983 11 10

Proj. N°. US/INT/83/085
Contract N°. 83/57

Report on Activities of
sixth UNIDO - Workshop
on Fertilizer Plant
Maintenance

Executing Agency: CHEMSERV CONSULTING GESELLSCHAFT MBH

Place of Training: CHEMIE LINZ AG, Linz, Austria

Period of Training: September 19 to November 4, 1983

Participants:
Mr. Mohammad Aqa RAHMATIAN
Mr. Zi-Xian XU
Mr. El Sayed M. OWIDAT
Mr. Hussein I. B. TAYEL
Mr. Dilip Kumar DAS
Mr. Wahyudi SUNARYO
Mr. Musa YAKUBU
Mr. Omar Ali MAMBOLEO
Mr. Leonard A. MASIMBA
Mr. Ali ACIKBAS
Mr. Noel Fred KAWANU

./2

Training Programme:

1st week: September 19 - September 23, 1983

General information about CHEMIE LINZ, Hostel, shopping facilities; ...
Slide report about CHEMIE LINZ products and plants; official opening of the sixth UNIDO WORKSHOP on FERTILIZER PLANT MAINTENANCE by CHEMIE LINZ board director Mr. Burger.
Introduction of department ATP (phosphat fertilizer).
Activities in central workshop, department ATG (gas reforming and water treatment) and electrical department.
Meeting with all instructors of workshop.

2nd week: September 26 - September 30, 1983

Meeting with civil engineering department. Visit to shut-down gypsum-sulphuric acid plant. Training in safety department and visit of firefighting equipment manufacturer.
Study tour to electrical companies (Sep. 28, 1983). Meeting with department MMV (stores) and instrument department, Lecture "Fundamentals of Maintenance".

3rd week: October 3 - October 7, 1983

Introduction of department ATN (nitrate fertilizer). Study tour to petrochemical plant at Vienna (Oct. 4, 1983).
Meeting with material testing department and introduction of department ATH (ammonia-high pressure facilities).
Meeting with CHEMIE LINZ energy control department, meeting with CHEMIE LINZ training institute.
Meeting with department BTH (urea-high pressure facilities).

./3

4th week: October 10 - October 14, 1983

The team was split up into several individual groups. The training took place in the technical sections of the ammonia plant (ATH), NPK-fertilizer plant (ATN) and urea plant (BTH); special instructions on central workshop, instrument department, material testing department. A study visit was arranged to a hydroelectric powerstation on the Danube (Oct. 9, 1983) and to heavy equipment manufacturer at Kapfenberg/Styria (Oct. 11, 1983)

5th week: October 17 - October 21, 1983

Activities were set in the technical section of ammonia plant (ATH), gas reforming and water treatment (ATG) and urea plant; electrical department (TEL). A study tour to Beat-fertilizer plant at Bürmoos/Salzburg and iron and steel manufacturer VOEST Alpine was arranged.

6th week: October 24 - October 28, 1983

During this period lectures and practical work took place in the technical section of NPK-fertilizer plant (ATN) and phosphat-fertilizer plant (ATP), electrical department (TEL) and instrument department (TME). Lectures were given on pollution control, cost control and budgeting. The works council arranged a study tour to an Upper Austrian farm (Oct. 28, 1983). Figers for consumption of fertilizers and crop yield were provided.

7[th] week: October 31 - November 4, 1983

The final week was spent in the technical section of the phosphat fertilizer plant and urea plant, instrument department and material testing department. On a study visit the participants went to a manufacturer of pumps and turbines.

Final meeting on November 4, 1983.

CHEM.L. [illegible]
IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIPO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible] plant [illegible] plant	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible] 2. Visit to [illegible] sulphuric acid plant.	[illegible]
[illegible]	[illegible]	[illegible] visit [illegible] and visit to [illegible]	[illegible]
[illegible]	[illegible]	Visit to [illegible] the chemical companies	[illegible]
[illegible]	[illegible]	[illegible] in [illegible] system [illegible] and Instrument Dept.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible] AG

IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LCS	[illegible]	[illegible]
[illegible]	PTA	[illegible]	[illegible]
[illegible]	LCS	Study tour [illegible]	[illegible]
[illegible]	PTA	[illegible] discussions	[illegible]
[illegible]	PTA [illegible]	Training in [illegible] plant / discussions [illegible]	[illegible]
[illegible]	PTA	General discussions	[illegible]
[illegible]	PTA	Training [illegible] and Water plant.	[illegible]
[illegible]	LCS	Study tour [illegible]	[illegible]
[illegible]	PTP	Visit to [illegible]	[illegible]
[illegible]	[illegible]	Visit to [illegible] plant and general discussions	[illegible]
[illegible]	LCS	Study tour [illegible]	[illegible]
[illegible]	PTP	Cement production [illegible] and NPK equipment and machinery	[illegible]
[illegible]	PTP	[illegible]	[illegible]
[illegible]	PTA	[illegible]	[illegible]
[illegible]	[illegible]	Study tour [illegible]	[illegible]
[illegible]	TAP	Types of [illegible] and ways of [illegible]	[illegible]

[illegible]

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible] Afghanistan

Project: UNIDO-Workshop

[illegible]te	Dept.	Aktivities	Signature CL
[illegible]	[illegible]	Visit to [illegible] hospital.	[illegible]
[illegible]	[illegible]	[illegible] visit to Pump [illegible].	
[illegible]	TMD	[illegible] cracks in vessels and pipes.	[illegible]
[illegible]		[illegible] to the Workshop.	

[illegible]
IVL

RECORD OF WORKING TIME

Month: SEPTEMBER [illegible]
Name: XU ZIXIAN
Nationality: China

Project: UNIDO-Workshop

[illegible]	Dept.	Aktivities	Signature CL
[illegible] 83		ARRIVAL AT CHEMIE LINZ ON THE AFTERNOON	
[illegible] 83	LCS ATP	MEETING AT GASTHAUSE NO 1 . VISITING CHEMIE LINZ JOB SITE	[illegible]
[illegible] 83	LCS	A SLIDE REPORT . BRIEF INTRODUCTION OF CHEMIE LINZ , MEETING WITH MR BURGER	[illegible]
[illegible] 9 83	ATP	A BRIEF INTRODUCTION OF ATP . VISITING ATP	[illegible]
[illegible] 09 83	TGL ATG	VISITING ELECTRIC WERK DEPARTMENT , MEETING WITH ATG	[illegible]
[illegible] 83	THN	A BRIEF INTRODUCTION OF THN AND VISITING THN	[illegible]
[illegible] 83	LCS	VISITING LINZ CITY	[illegible]
[illegible] 09 83	TBN ATP	MEETING WITH DEPARTMENT TBN , MEETING WITH MR. GRAUSAM . VISITING GYPSUM PLANT	[illegible]
[illegible] 83	US	MEETING WITH US. VISITING FIRE BRIGADE AND ASSOCIATED WORKSHOP, ROSENBAUER	[illegible]
[illegible] 09 83	LCS	VISITING ELETRICAL COMPANY	[illegible]
[illegible] 09 83	MMV . TME	MEETING WITH MMV AND MR. GRAUSAM . VISITING DEPARTMENT STORE . DISCUSSION	[illegible]
		WITH TME	
[illegible] 09 83	ATP	" FOUNDAMENTAL MAINTENANCE " BY MR. GRAUSUM.	[illegible]

徐子显
83 [illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: OCT 1983
Name: XU ZIXIAN
Nationality: CHINA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible] 10 83	ATN	MEETING AND VISITING ATN	[signature]
[illegible] 10 83	LCS ATN	STUDY TOUR TO VIENNA AND VISITING POLYPROPELENE PLANT	[signature]
[illegible] 10 83	ATH TMP	MEETING WITH DEPARTMENT ATH AND TMP	[signature]
[illegible] 10 83	LCS	MEETING WITH WORKS COUNCIL AND VISITING TRAINING INSTITUTE	[signature]
[illegible] 10 83	BTH	MEETING WITH BTH AND VISITING UREA AND MELAMINE PLANT	[signature]
[illegible] 10 83	THN	DISSCUSION WITH THN	[signature]
[illegible] 10 83	~~THN~~ LCS	~~DISCUSSION WITH THN~~ STUDY TOUR TO KAPFENBERG VISITING VEW	[signature]
[illegible] 10 83	THW	DISCUSSION WITH THW	[signature]
[illegible] 10 83	ATN THN	DISCUSSION WITH ATN AND THN	[signature]
[illegible] 10 83	THN	DISCUSSION WITH THN	[signature]
[illegible] 10 83	ATH	DISSCUSION WITH ATH	[signature]
[illegible] 10 83	LCS	STUDY TOUR TO SALZBURG. VISITING PEAT FERTILIZER	[signature]
[illegible] 10 83	ATH	DISCUSSION WITH ATH	[signature]
[illegible] 10 83	ATH	DISCUSSION WITH ATH	[signature]
[illegible] 10 83	LCS	STUDY TOUR TO VÖEST-ALPINE	[signature]
[illegible] 10 83	ATP	DISCUSSION WITH ATP	[signature]
[illegible] 10 83	ATP	DISCUSSION WITH ATP	[signature]
[illegible] 10 83		NATIONAL HOLIDAY OF AUSTRIA	
[illegible] 10 83	ATP	DISCUSSION WITH ATP	
[illegible] 10 83	LCS/GBK	STUDY TOUR TO COUNTRYSIDE	
[illegible] 10 83	BTH	MEETING AND VISITING IN BTH.	[signature]
[illegible] 10 83	LCS	VISITING POWER STATION ASTEN	[signature]

[signature] 83.10.31

[illegible] AG

IVL

RECORD OF WORKING TIME

Month: NOV 1983
Name: XU ZHIAN
Nationality: CHINA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
1 11 83	LCS	STUDY TOUR TO POWER STATION KAPPIN	[signature]
2 11 83	~~[illegible]~~ TEL	BALANCING, STUDY TOUR TO PUMP PLANT IN LINZ	[signature]
3 11 83	BTH	DISCUSSION WITH BTH	[signature]
4 11 83	TMP	DISCUSSION WITH TMP	[signature]

[signature] 11.4

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month:
Name:
Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
			Wang
			Wang

C… AG

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL

[illegible] AG

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
			[illegible]
			[illegible]
			[illegible]
			[illegible]

[illegible] AG

IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
		[illegible]	
		[illegible]	[illegible]
		[illegible]	
		[illegible]	
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	
		[illegible]	Wang
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	Wang
		[illegible]	[illegible]
		[illegible]	[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Ch
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	
		[illegible]	[illegible]
		[illegible]	[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]		[illegible]	[signature]
[illegible]		[illegible]	
[illegible]		[illegible]	[signature]
		[illegible]	[signature]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month:
Name:
Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month: SEPTEMBER [illegible]
Name: W. SUNARYO
Nationality: INDONESIA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	—	ARRIVAL AT LINZ	
[illegible]	—	SUNDAY (HOLIDAY)	
[illegible]	[illegible] ATP	GENERAL INFORMATION AND SURVEY TO CHEMIE LINZ FACILITIES	
[illegible]	[illegible] ATP	[illegible] REPORT, GENERAL INFORMATION & OFFICIAL OPENING OF THE WORKSHOP	
[illegible]	ATP	INTRODUCTION OF DEPT ATP DISCUSSION OF [illegible] PROBLEMS, ETC	
[illegible]	[illegible]	DISCUSSION ABOUT ELECTRICAL ENGINEERING DEPT AND GAS PURIFYING WATER TREATMENT DEPT	[illegible]
[illegible]	TMW	DISCUSSION ABOUT CENTRAL WORKSHOP DEPT	[illegible]
[illegible]	—	SATURDAY (HOLIDAY)	
[illegible]	—	SUNDAY (HOLIDAY) - SIGHT SEEING [illegible] THROUGH LINZ GUIDED BY MR. HERZOG	[illegible]
[illegible]	[illegible] ATP	DISCUSSION ABOUT CIVIL DEPT, SAFETY REGULATION, VISITED TO GYPSUM PLANT [illegible] DOWN	
[illegible]	[illegible]	DISCUSSION WITH SAFETY DEPT, VISITED TO "ROSENBAUER" COMPANY.	[illegible]
[illegible]	[illegible]	VISITED ELECTRICAL COMPANY i.e. SPRECHER + SCHUH GMBH & ELECTRO [illegible] AG	[illegible]
[illegible]	MHV TME	SPARE PARTS [illegible], DISCUSS WITH MHV-DEPT AND TME DEPT.	[illegible]
[illegible]	ATP	LECTURE [illegible] OF MAINTENANCE BY MR. [illegible]	[illegible]

CHEMIE LINZ AG

IVL

Month: OCTOBER [illegible]

Name: [illegible] SUNARYO

Nationality: INDONESIA

RECORD OF WORKING TIME

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
	ATV	DISCUSSION WITH ATV DEPT., VISITED TO NITRATE FERTILIZER PLANT.	[illegible]
	[illegible]	STUDY TOUR TO [illegible] PLANT AND WIENNA CITY	
	ATV, IMP	INTRODUCTION OF ATV DEPT. VISITED [illegible] PLANT, DISCUSSION WITH IMP DEPT.	[illegible]
	[illegible]	MEETING WITH [illegible] COUNCIL AND [illegible] INSTITUTE.	[illegible]
	ATV	DISCUSSION WITH ATV DEPT., VISITED THE UREA & MELAMINE PLANTS	[illegible]
	LCS	STUDY TOUR TO [illegible] POWER STATION ASTEN.	[illegible]
	TME	DISCUSSION WITH INSTRUMENT-WORKSHOP	[illegible]
	LCS	STUDY TOUR TO KAPFENBERG, VEW STEEL WORKS.	[illegible]
	TME	INSTRUMENT WORKSHOP, DISCUSS ABOUT MICRO PROCESSOR	[illegible]
	TME, TKP	INSTRUMENT TRAINING FACILITIES, MIDTERM REVIEW (UNIDO) & DESIGN ENGINEERING DEPT	[illegible]
	TME	INSTRUMENT WORKSHOP, VISITED THE COMPUTER FOR PROCESS CONTROL & [illegible] PANEL	
	TEL	VISITED & DISCUSSION WITH ELECTRONIC WORKSHOP GROUP.	[illegible]
	LCS	STUDY TOUR TO [illegible] FERTILIZER [illegible]	[illegible]
	TEL	DISCUSSION WITH ELECTRONIC PLANT GROUP. VISITED SUB STATION OF UREA & [illegible] PLANT	[illegible]
	TEL	[illegible] VISITED SUBSTATION [illegible] TREATMENT PLANT [illegible]	
	LCS	STUDY TOUR TO VOEST ALPINE / STEEL WORKS	[illegible]
	TEL	DISCUSSION [illegible]	
	[illegible]	[illegible] CONTROL	[illegible]
		[illegible]	
	[illegible]	[illegible]	
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]

[illegible] AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: Mr [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]	[illegible]		
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]	—	[illegible]	

LCS

RECORD OF WORKING TIME

Month: September 1983
Name: YAKUBU Musa
Nationality: Nigeria

Project: UNIDO-Workshop

(7)

Date	Dept.	Aktivities	Signature CL
[illegible]		ARRIVAL TO LINZ	
[illegible]		SIGHT SEEING OF HISTORIC PLACES AT LINZ	LCS [illegible]
[illegible]	TPK	LECTURE [illegible]	[illegible]
[illegible]	US	[illegible]	
[illegible]		VISIT TO [illegible] [illegible]	LCS [illegible]
[illegible] 83	TYE M	LECTURE ON SPARE PARTS SYSTEM. VISIT TO SPARE PARTS DEPT. LECTURE ON INSTRUMENT DEPT.	[illegible]
[illegible] 83		LECTURE ON 'FUNDAMENTALS OF MAINTENANCE'	
[illegible]		HOLIDAY	
[illegible]		HOLIDAY	
[illegible]			

I.C.

Month: October 1983
Name: Mr. Yakubu
Nationality: Nigeria

RECORD OF WORKING TIME

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]-83		Saturday - Holiday	
[illegible]		Sunday - Holiday	
[illegible]-83	ATN	LECTURE ON THE [illegible] OF UP PRODUCTS, AND PRODUCTION PROCESS OF (ATN) DEPT.	[signature]
[illegible]		STUDY TOUR [illegible]	[signature]
[illegible]-83	TMT ATN	LECTURE ON THE ACTIVITIES OF ATN DEPT. LECTURE ON THE ACTIVITIES OF [illegible]	[signature]
0[illegible]		[illegible]	[signature]
[illegible]-83	[illegible]	[illegible]	[signature]
[illegible]-83		[illegible]	
[illegible]-83		VISIT [illegible] historic p[illegible]	[signature]
[illegible]-10-83	TM[illegible]	[illegible]	[signature]
1[illegible]-10-83		[illegible]	[signature]
[illegible]-10-83	[illegible]	[illegible]	[signature]
[illegible]-10-83	[illegible]	THE DAY [illegible] LEADERS OF CL WERE [illegible]	
[illegible]-10-83	TM[illegible]	ATTACHMENT [illegible]	
[illegible]-83		HOLIDAY	
[illegible]-83		HOLIDAY	
[illegible]-83	[illegible]	ATTACHMENT TO THE [illegible] ([illegible]) [illegible] Supply.	[signature]
[illegible]-83		VISIT TO A [illegible] VISIT TO [illegible]	[signature]
[illegible]	[illegible]	ATTACHMENT [illegible]	[signature]
[illegible]	[illegible]	[illegible]	[signature]
[illegible]		[illegible]	[signature]
[illegible]		HOLIDAY (SATURDAY)	

[signature]

[illegible] AG

IVL

RECORD OF WORKING TIME

Month: OCT. 1983
Name: MR YAKUBU MUSA
Nationality: NIGERIA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
23-10-83		SUNDAY HOLIDAY	
24-10-83	ATP	ATTACHMENT TO THE ATP DEPT. LECTURE ON COST CONTROL	
25-10-83	ATP	ATTACHMENT TO THE ATP DEPT. DISCUSSION AND EXCURSION TO THE PLANT.	
26-10-83		NATIONAL HOLIDAY	
27-10-83	ATP	ATTACHMENT TO THE ATP DEPT. DISCUSSION AND EXCURSION TO THE PLANT.	
28-10-83		EXCURSION TO HÖRSCHING AND ~~THE~~ SOME FAMOUS FARMS.	[signature]
29-10-83		HOLIDAY (SATURDAY)	
30-10-83		HOLIDAY (SUNDAY)	
31-10-83	TMP	ATTACHMENT TO THE MATERIAL TESTING DEPT.	[signature]

[signature]

C[illegible]

IVL

RECORD OF WORKING TIME

Month: Nov. 1983
Name: MR YAKUBU M[illegible]SA
Nationality: NIGERIA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
1-11-83		TRIP TO THE ~~[illegible] AND~~ KAPRUN HYDROELECTRIC POWER STATION.	
[illegible]-11-83		LECTURE ON BALANCING, POLLUTION CONTROL AND VISIT TO OCHSNER PUMP COMPANY.	
[illegible]-11-83	TMP	ATTACHMENT TO MATERIAL TESTING DPT. MEETING WITH THE WORK COUNCIL	
[illegible]-11-83	TMP	ATTACHMENT TO THE MATERIAL TESTING DEPT. RETURN OF WORKING DRESSES	
		PRESENTATION OF CERTIFICATES, PHOTO ALBUM AND UNIDO REPORT.	

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
		[illegible]	
		[illegible]	
		[illegible]	
[illegible]		[illegible]	
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
		[illegible]	[illegible]
[illegible]		[illegible]	
		[illegible]	[illegible]
		[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]		[illegible]	

IVL

RECORD OF WORKING TIME

Month:

Name:

Nationality:

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	Wang
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	Wang
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	Wang
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	Wang
[illegible]		[illegible] MORNING - CONTINUATION STUDY AT MATERIAL TESTING DEPT.	[illegible]
[illegible]	[illegible]	[illegible] DAY STUDY AT UREA AND [illegible] PLANT.	[illegible]
[illegible]	[illegible]	[illegible] DAY STUDY [illegible] UREA AND [illegible] PLANT.	[illegible]
[illegible]	[illegible]	[illegible] DAY STUDY AT [illegible] DEPT.	[illegible]
[illegible]		[illegible]	Wang
[illegible]	[illegible]	[illegible] PLANTS	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]		[illegible] DAY VISIT TO [illegible] COMPANY.	Wang
[illegible]	[illegible]	[illegible] DAY DISCUSSION AT [illegible] DEPARTMENT.	
[illegible]	[illegible]	[illegible] DAY DISCUSSION AT [illegible] DEPARTMENT - COST CONTROL	[illegible]
[illegible]	[illegible]	[illegible] DAY DISCUSSION AT [illegible] DEPARTMENT	
[illegible]		STUDY TOUR [illegible]	Wang
[illegible]	[illegible]	[illegible] DAY DISCUSSION AT [illegible] DEPARTMENT	[illegible]

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	
	[illegible]	[illegible]	
[illegible]		[illegible]	[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
		[illegible]	
	[illegible]	[illegible]	
		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
		[illegible]	[illegible]
		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
		[illegible]	

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]		[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
			[illegible]

CHEMIE LINZ AG
IVL

RECORD OF WORKING TIME

Month: [illegible]
Name: [illegible]
Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]		[illegible]	
[illegible]		[illegible] / SURVEY TO CHEMIE LINZ FACILITIES	
		[illegible] / [illegible]	[illegible]
	[illegible]	[illegible]	[illegible]
	[illegible]	[illegible] DEPT [illegible]	[illegible]
[illegible]	[illegible]	[illegible] AND VISIT OF CENTRAL WORKSHOP	[illegible]
[illegible]	[illegible]	SHORT [illegible]	Wang
[illegible]	[illegible]	[illegible] DEPT / SAFETY INSTRUCTIONS / [illegible]	[illegible]
[illegible]	[illegible]	GENERAL [illegible] ABOUT SAFETY DEPT. / VISIT TO [illegible]	[illegible]
[illegible]	[illegible]	VISIT TO [illegible] COMPANIES IN LINZ – [illegible]	Wang
[illegible]	[illegible]	INSTRUCTIONS TO SPARE PART SYSTEMS OF [illegible] AND INST DEPT	
[illegible]	[illegible]	[illegible]	[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: [illegible]

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible] ABOUT [illegible] PLANT AND [illegible]	
[illegible]	[illegible]	[illegible] / [illegible] ANSTRI	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	STUDY [illegible]	
[illegible]	[illegible]	A) VISIT TO [illegible] AND [illegible] PLANT AND MEETING / [illegible]	
[illegible]	[illegible]	[illegible] / [illegible]	
[illegible]	[illegible]	VISIT AT [illegible]	
[illegible]	[illegible]	VISIT TO [illegible]	
[illegible]	[illegible]	STUDY TOUR TO [illegible] AT [illegible] / [illegible]	
[illegible]	[illegible]	VISIT TO [illegible]	
[illegible]	[illegible]	VISIT TO [illegible] PLANT / [illegible]	
[illegible]	[illegible]	STUDY TOUR TO [illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible] / [illegible] / [illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	[illegible]	

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: ALI HAYDAR A[illegible]

Nationality: TURKEY

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]	[illegible]	[illegible] HYDROELECTRIC POWER STATION [illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	PREVENTIVE MAINTENANCE OF [illegible]	[illegible]

[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: ZAMBIA

(42)

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	–	[illegible] TO CHEMIE LINZ	
[illegible]	–	[illegible]	[illegible]
[illegible]	–	[illegible] ATP	
[illegible]	–	MEETING [illegible] AND ATG	[illegible]
[illegible]	–	MEETING WITH [illegible] TEEL	[illegible]
[illegible]	–	CONDUCTED TOUR OF LINZ BY MR HERZOG	[illegible]
[illegible]	–	MEETING [illegible] VISIT TO GYPSUM-SULPHURIC ACID PLANT [illegible]	[illegible]
[illegible]	–	MEETING [illegible] ~~[illegible]~~ SAFETY DEPT. STUDY VISIT TO ROSENBAUER COMPANY	[illegible]
[illegible]	–	STUDY VISIT TO ELECTRICAL COMPANIES [illegible] ELECTRIC [illegible]-AG	[illegible]
[illegible]	–	MEETING WITH DEPTS MIMV AND TME	
[illegible]	–	LECTURE ON "FUNDAMENTALS OF MAINTENANCE"	[illegible]

CHEMIE LINZ AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible]

Nationality: ZAMBIA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature Cl.
[illegible]	-	[illegible]	[illegible]
[illegible]	-	[illegible] VIENNA	[illegible] Wang
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	-	[illegible]	Wang
[illegible]	-	[illegible]	[illegible]
[illegible]	-	[illegible]	Wang
[illegible]	[illegible]	PLANNING AND [illegible]	[illegible]
[illegible]	—	STUDY TOUR [illegible] KAPFENBERG	Wang
[illegible]	[illegible]	[illegible] AND ORGANIZATION	[illegible]
[illegible]	-	[illegible] WITH UNIDO AND AUSTRIAN GOVT OFFICIALS [illegible]	
[illegible]	[illegible]	VALVE MAINTENANCE AND REPAIR	
[illegible]	[illegible]	[illegible] COMPRESSOR WORKS	[illegible]
[illegible]	—	[illegible]	Wang
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	—	STUDY TOUR [illegible] ALPINE	Wang
[illegible]	[illegible]	[illegible] AND MACHINERY	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	Wang
[illegible]	[illegible]	[illegible] AND [illegible]	[illegible]

CHEMIE WERK AG

IVL

RECORD OF WORKING TIME

Month: [illegible]

Name: [illegible] KAWAMA [illegible]

Nationality: ZAMBIA

Project: UNIDO-Workshop

Date	Dept.	Aktivities	Signature CL
[illegible]	—	[illegible] (CEL) [illegible] TOUR OF [illegible]	
[illegible]	[illegible]	[illegible] AND [illegible] COUNCIL	
[illegible]	—	VISIT TO KAF[illegible] (HYDRO ELECTRIC POWER STATION)	[illegible]
[illegible]	—	[illegible] (CEL) [illegible] CENTRE AND [illegible] TOUR OF [illegible]	[illegible]
[illegible]	[illegible]	[illegible] (TAP) AND MEETING WITH [illegible] COUNCIL	
[illegible]	—	CLOSURE OF THE SIXTH WORKSHOP	[illegible]

Detailed financial statement for

allowances, lodging, etc.

	Days	1. Lodging a 160,-/ day	2. a) Travel days b) 20 % of allow. c) d) e) full board	3. UNIDO Part of travelling cost
Mr. XU Zi-Xian	50	8 000,--	27 037,24	400,--
Mr. OWIDAT E. S. M.	49	7 840,--	27 037,24	400,--
Mr. TAYEL H. I. B.	49	7 840,--	27 037,24	400,--
Mr. DAS D. K.	54	8 640,--	28 918,12	400,--
Mr. SUNARYO W.	49	7 840,--	27 037,24	400,--
Mr. JAKUBU M.	42	6 720,--	25 852,24	400,--
Mr. MAMBOLEO O. A.	50	8 000,--	28 062,68	400,--
Mr. MASIMBA L. A.	50	8 000,--	28 062,68	400,--
Mr. ACIKBAS A.	50	8 000,--	27 037,24	400,--
Mr. KAWANU N. F.	48	7 680,--	27 037,24	400,--
Mr. RAHMATIAN M. A.	48	7 680,--	27 037,24	400,--
	539	S 86 240,--	S 300 156,40	S 4 400,--

Total amount for 1., 2. and 3. ... -	S 390 796,--
transfered amount	S 399 487,--
amount to be transfered to UNIDO	S 8 691,--

Detailed financial statement
for sixth UNIDO-Workshop in Linz

1. An average of 5 CL-personnel were engaged for every week of the period of training. 5 personnel x 7 weeks x S 18 700,-- fee	S	654 500,--
2. 7 % administrative surcharge / telexes, letters, visas, lost luggage, reports, TV rent, procurement of retourn tickets, helmets, goggles, working clothes, jackets, gasmasks	S	45 815,--
3. Workshop documentation 4 500 Xerox copies ... S 2250,-- Translations German - English S 35 797,--	S	38 007,--
4. Subsidy to the cost of daily meals in CL-canteen for menüs for Moslems Cost for meal =S 12,-- subsidy = S 48,-- 360 meals x S 48,--	S	17 280,--
5. Newspapers and spec. literatur Herald Tribune, Gardian, New Statesmann, Code of Practice for Industry	S	6 866,--
6. Study visits and social activities bus fares S 27 587,--, Exibition tickets S 2 065,--	S	29 652,--
7. Special dinners and presents, approx.	S	20 000,--
8. Transportation costs Public transport: 33 weekly tickets a S 85,-- 11 monthly tickets a S 320,--	S	6 305,--
airport to accommodation and retourn 5 300,-- - 4 400,-- Unido part	S	900,--
9. Fotos and albums	S	3 792,--
total	S	823 117,--
fee for workshop	S	630 000,--
contribution in kind	S	193 117,--

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. Mohammad Aqa RAHMATIAN
from
Ministry of Mines and
Industries Kabul
Afghanistan

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	Hausruf	Linz
		LCS/He/Wh	2236	1983 10 18

Betreff Sachbearbeiter

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per-day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) 6 weekends, A.S. 230,-- per day .... A.S. 2.760,--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Rahmatian)

Bitte die gekennzeichneten Zeichen anführen

A 11/77

chem...
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. Leonard A. MASIMBA
from
Tanzania Fertilizer Co.
Tanga
Tanzania

Fernruf (Telephone)
Linz (0732) 59' Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen*)	Hausruf	Linz, St.-Peter-Straße 25
		LCS/He/Wh	2236	1983 11 04

Betreff
Arrival in Linz: 1983 09 18
Departure : 1983 11 07

Bearbeiter
Mr. Herzog

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for 4 travel days of A.S. 1413,60 per day	A.S.	5.654,40
b) 20 % of daily subsistence allowance rate as pocket money A.S. 282,72 per day x 49 days	"	13.853,28
c) Full board for 7 weeks Monday to Friday, A.S. 145,-- per day	"	5.075,--
d) 7 weekends, A.S. 230,-- per day	"	3.220,--
e) 2 holidays (add), A.S. 130,--	"	260,--
Total	A.S.	28.062,68

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Masimba)

*) Bei Beantwortung ... bitten
... Zeichen anzuführen

LCS)He/Wh

1983 11 04

I confirm having received from CHEMSERV CONSULTING the following amount for the weekend before homeflight:

1 weekend, A.S. 230,-- per day .... A.S. 460,--
Pocket money for 2 days à
A.S. 282,72 per day .... " " 565,44

Total A.S. 1.025,--
====================

Mr. MASIMBA ....
~~Mr. MAMBOLEO~~ ....

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. Ali ACIKBAS
from
Istanbul Gübre Sanayii AS
Kocaeli
Turkey

Fernruf (Telephone)
Linz (0 73 2) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	Nebenstelle	Linz
		LCS/He/Wh	2236	1983 10 18

Betreff

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per-day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) [illegible] weekends, A.S. 230,-- per day .... A.S. [illegible],--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Acikbas)

A 11/17

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Mr. Noel Fred KAWANU
from
Nitrogen Chemicals of Zambia Ltd.
Kafue
Zambia

[illegible]	[illegible]	Unser Zeichen	[illegible]	[illegible]
		LCS/He/Wh	2236	1983 10 18

[illegible]

Chemserv Consulting GesmbH has provided the above stated work-shop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per-day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) [illegible] weekends, A.S. 230,-- per day .... A.S. 2.76[illegible],--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Kawanu)

[illegible]

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Fernruf (Telephone)
Linz (0732) 59: Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Mr.
Zi-Xian XU
from
Sichuan Chemical Plant
Cheng Du, PR. China

Ihre Zeichen	Ihre Nachricht vom	Unser Zeichen	Nebenstelle	Linz
		LCS/He/Wh	2236	1983 10 18

Betreff

Bearbeiter

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per-day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) 6 weekends, A.S. 230,-- per day .... A.S. 2.760,--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24
=====================

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

徐子显

(Zi-Xian XU)

A11h7

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. El Sayed M. OWIDAT
from
Fertilizer & Chemical Ind.
Talkha
Egypt

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Ihre Zeichen	Ihre Nachricht vom	Unser Zeichen	Hausruf	Linz,
		LCS/He/Wh	2236	1983 10 18

Betreff

Bearbeiter

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for 4 travel days of A.S. 1413,60 per-day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate as pocket money A.S. 282,72 per day x 47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) 6 weekends, A.S. 230,-- per day .... A.S. 2.760,--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Owidat)

chemserv
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Mr. Hussein I. B. TAYEL
from
Abu Qir, Fertilizer & Chem. Ind.
Alexandria
Egypt

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	Hausruf	Linz
		LCS/He/Wh	2236	1983 10 18

Betreff

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) 6 weekends, A.S. 230,-- per day .... A.S. 2.760,--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Tayel)

A 11/17

chem
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. Dilip Kumar DAS
from
Hindustan Fertilizer Corp.
Durgapur
India

Fernruf (Telephone)
Linz (0 73 2) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen*)	Hausruf	Linz, St.-Peter-Straße 25
		LCS/He/Wh	2236	1983 10 18

Betreff: Arrival in Linz: 1983 09 16
Departure to Fr.:1983 11 09

Bearbeiter: Hr. Herzog

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for 4 travel days of A.S. 1413,60 per day ...	A.S.	5.654,40
b) 20 % of daily subsistence allowance rate as pocket money A.S. 282,72 per day x 51 days	"	14.418,72
c) Full board for 7 weeks Monday to Friday, A.S. 145,-- per day	"	5.075,--
+ 2 days à A.S. 145,--	"	290,--
d) 7 weekends, A.S. 230,-- per day	"	3.220,--
e) 2 holidays (add), A.S. 130,--	"	260,--
Total	A.S.	28.918,12

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Dilip Kumar DAS)

A 11/17

LCS/He/Wh
1983 11 04

I confirm having received from CHEMSERV CONSULTING the following amount for the exceeding days of the workshop (one weekend + 2 days)

Full board à S.S. 145,- per day	....	A.S. 290,--
1 weekend à A.S. 230,- " "	....	" " 460,--
Pocket money for 4 days à A.S. 282,72 per day	....	" " 1130,88
	Total	A.S.1.880,88

(Dilip Kumar DAS) 4/11/83

chem
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Mr. Wahyudi SUNARYO
from
P.T. Pupuk Sriwidjaja (Pusri)
Palembang
Indonesia

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen	Hausruf	Linz
		LCS/He/Wh	2236	1983 10 18

Betreff — Bearbeiter

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... A.S. 13.287,84

c) Full board for 7 weeks Monday to
Friday, A.S. 145,-- per day .... A.S. 5.075,--

d) 6 weekends, A.S. 230,-- per day .... A.S. 2.760,--

e) 2 holidays (add), A.S. 130,-- .... A.S. 260,--

Total A.S. 27.037,24

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Sunaryo)

chem[illegible]

CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 02 1324

Mr. MUSA JAKUBU
from
Nigeria

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen*)	Hausruf	Linz, St.-Peter-Straße 25
		LCS/He/Wh	2236	1983 10 20

Betreff

Bearbeiter

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for
4 travel days of A.S. 1413,60 per day ... A.S. 5.654,40

b) 20 % of daily subsistence allowance rate
as pocket money A.S. 282,72 per day x
47 days .... " 13.287,84

c) Full board for 6 weeks Monday to
Friday, A.S. 145,-- per day .... " 4.350,--

d) 5 weekends, A.S. 230,-- per day .... " 2.300,--

e) 2 holidays (add), A.S. 130,-- per day ... " 260,--

Total A.S. 25.852,24
===================

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Mr. Musa JAKUBU)

*) [illegible]

A 11/17

chem...
CONSULTING GES.M.B.H.

Postanschrift des Absenders
CHEMIE LINZ AG, Postfach 296, A-4021 Linz, Austria

Mr. Omar Ali MAMBOLEO
from
Tanzania Fertilizer Co.
Tanga
Tanzania

Fernruf (Telephone)
Linz (0732) 591 Durchwahl
Drahtanschrift (Telegrams)
Chemie Linz
Fernschreiber (Telex) 021324

Ihr Zeichen	Ihre Nachricht vom	Unser Zeichen*)	Hausruf	Linz, St.-Peter-Straße 25
		LCS/He/Wh	2236	1983 11 04

Betreff Arrival in Linz: 1983 09 18
Departure : 1983 11 07

Bearbeiter Mr. Herzog

Chemserv Consulting GesmbH has provided the above stated workshop participant with the following allowances and subsidies:

a) A daily subsistence allowance for 4 travel days of A.S. 1413,60 per day	A.S.	5.654,40
b) 20 % of daily subsistence allowance rate as pocket money A.S. 282,72 per day x 49 days	"	13.853,28
c) Full board for 7 weeks Monday to Friday, A.S. 145,-- per day	"	5.075,--
d) 7 weekends, A.S. 230,-- per day	"	3.220,--
e) 2 holidays (add), A.S. 130,--	"	260,--
Total	A.S.	28.062,68

His accomodation at A.S. 160,-- per day was also financed by Unido.

The participant confirms that he has received the above stated amount:

(Mamboleo)

*) Bei Beantwortung anführen!

A 11/17

LCS)He/Wh

1983 11 04

I confirm having received from CHEMSERV CONSULTING the following amount for the weekend before homeflight:

1 weekend, A.S. 230,-- per day	A.S. 460,--
Pocket money for 2 days à	
A.S. 282,72 per day	" " 565,44
Total	A.S. 1.025,--

~~Mr. MASIMBA~~ ....

Mr. MAMBOLEO ....

HISTRORICAL DEVELOPMENT OF CHEMIE LINZ AG

Start of erection work in 1940, heaping up the area near the Danube for 2 - 4 meters with gravel from the port.
Question of location: the new plant was situated next door to VOEST because there was a surplus of coke oven gas.

The original name of our company was "Oesterreichische Stickstoffwerke AG" (translated: Austrian Nitrogen Plants Ltd.). Initially only nitrogen fertilizers were produced. This old name was too complicated and too long for international use. So we changed it to "CHEMIE LINZ AG" some years ago.

Original layout of our facilities:

1st extension step: 50 000 t N
2nd extension step: 100 000 t N
Start of production - Primary N: October 1942
CAN : March 1943

In the year 1944 we had reached a production of 55 000 t primary N.

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During the second world war our plant was hit by 800 bombs. From May 1945 to July 1946 production partly stood still due to damage and shortage of power.
In 1948 the former production level was reached again.

It was boosted strongly in the following years.

	1957	1967	1977
Production of primary N:	164 000 t/a	275 000 t/a	466 000 t/a

The number of different products increased during the same time from 200 to 1300.

The most important results of our chemical-technical investigations you will find in the CHEMIE LINZ Know-How brochure.

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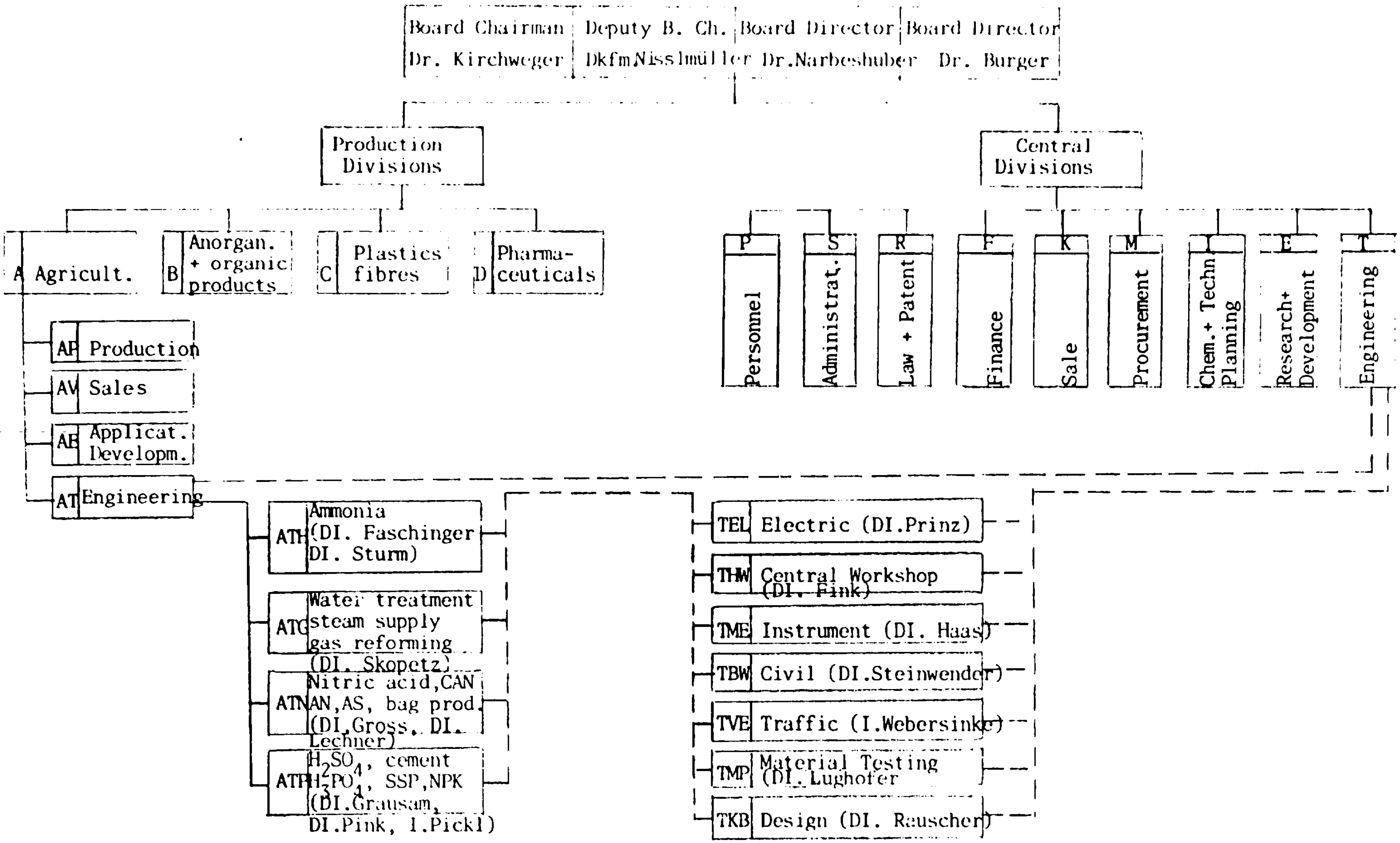
The most significant erections:

1939	Foundation of the enterprise "Österreichische Stickstoffwerke AG" with a target of 50 000 t N per annum.
1943	Start-up as an enterprise producing only nitrogenous fertilizers.
1944/45	800 bomb hits, closing of the plant
1945/46	Reconstruction, installation of the departments investigation, development, sales and training.
1948	Foundation of pharmaceutical division and continuous extension of all plants.
1953	Foundation of the production line for plant protective agents.
1954	Start of the plants "Gypsum Sulphuric Acid" and SSP.
1960	Start of organic production facilities (preplastics and plastics).
1975	Erection of the plant at Enns (acrylonitrile).

ORGANIZATION OF CHEMIE LINZ AG



TEL	Central engineering, electrical department Planning of electrical equipment of new Chemie Linz plants, electrical maintenance, balancing of rotors
TME	Central engineering, instrument department Planning of instrumentation systems, weighing systems, maintenance and repair
TMP	Central engineering, material testing department Recommendations concerning material selection for new and existing plants, checking of welding seams, corrosion test,...

You will have also the opportunity to visit the following departments for a short time:

TBW	Central engineering, civil department Planning of new buildings and maintenance of buildings, streets, rails, sewerage. Insulation and painting group.
US	Safety department Safety instructions, registration of accidents, fire brigade, safety kit (masks, filters, respirators,...)
TKB	Central engineering, design Coordination of all investments (new plants), improvements in existing plants together with production- and maintenance departments, working out of drawings and investment programs.

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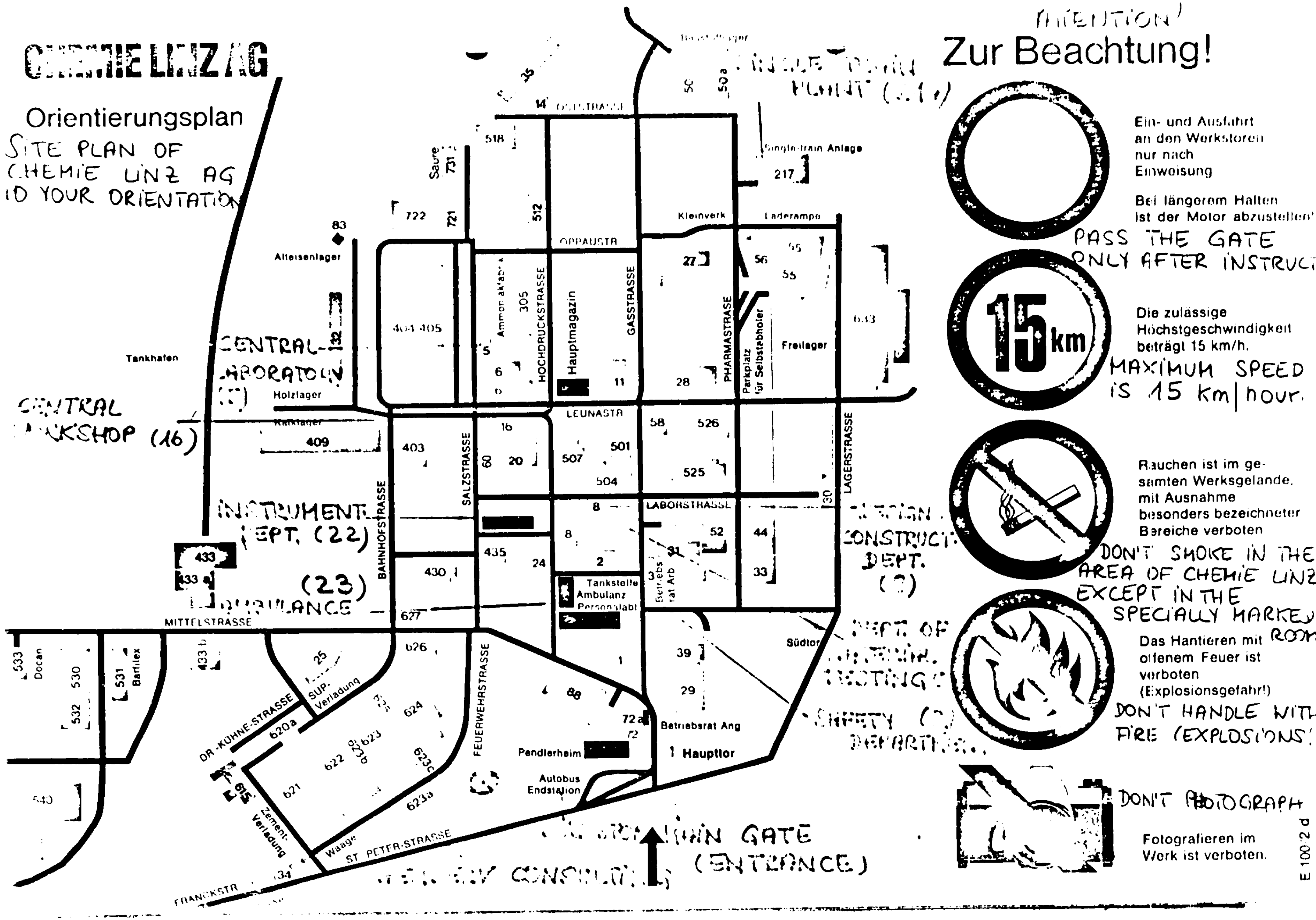
LCS	(CHEMSERV CONSULTING)-a 100% subsidiary of Chemie Linz AG Central planning licenses Licenses and know-how from Chemie Linz AG
GBR	Discussion with members of the works council
MMV	Central division M (procurement) Stores, computer system
PAW	Central division P (personnel), training school Training of apprentices, workers and employees in lectures and courses.



CHEMIE LINZ AG
Orientierungsplan
SITE PLAN OF CHEMIE LINZ AG TO YOUR ORIENTATION
Zur Beachtung!
ATTENTION!
Ein- und Ausfahrt an den Werkstoren nur nach Einweisung
Bei längerem Halten ist der Motor abzustellen!
PASS THE GATE ONLY AFTER INSTRUCT
15 km
Die zulässige Höchstgeschwindigkeit beträgt 15 km/h.
MAXIMUM SPEED IS 15 km/hour.
Rauchen ist im gesamten Werksgelände, mit Ausnahme besonders bezeichneter Bereiche verboten
DON'T SMOKE IN THE AREA OF CHEMIE LINZ EXCEPT IN THE SPECIALLY MARKED ROOMS
Das Hantieren mit offenem Feuer ist verboten (Explosionsgefahr!)
DON'T HANDLE WITH FIRE (EXPLOSIONS!)
DON'T PHOTOGRAPH
Fotografieren im Werk ist verboten.
E 100.2 d
CENTRAL LABORATORY
CENTRAL ...NKSHOP (16)
INSTRUMENT DEPT. (22)
(23)
AMBULANCE
CONSTRUCT DEPT.
POINT
MAIN GATE (ENTRANCE)
Tankhafen
Alteisenlager
Holzlager
Kalklager
Ammoniakfabrik
Hauptmagazin
Kleinverk
Laderampe
Single-train Anlage
Freilager
Parkplatz für Selbstabholer
Tankstelle Ambulanz Personalabt
Betriebsrat Arb
Betriebsrat Ang
Pendlerheim
Autobus Endstation
1 Haupttor
Südtor
SUP. Verladung
Zement-Verladung
Waage
Docan
Barlilex
OSTSTRASSE
OPPAUSTR
LEUNASTR
LABORSTRASSE
MITTELSTRASSE
ST PETER-STRASSE
FRANCKSTR
DR.-KÜHNE-STRASSE
HOCHDRUCKSTRASSE
GASSTRASSE
PHARMASTRASSE
LAGERSTRASSE
SALZSTRASSE
BAHNHOFSTRASSE
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MECHANICAL JOBS FOR OPERATORS

During start-up of a new plant we normally have some maintenance personnel in shift (1 or 2 shift fitters). If the plant is in continuous operation there is no maintenance personnel in shift. For the complete plant of Chemie Linz only in two departments (ATN and ATP) each one shift fitter is working. For example the single train ammonia plant, water treatment and also urea plant don' t have a shift fitter. If there is a fault the operating people (production) can call the stand-by service (on call service).

For every production department

1 chemical engineer or production foreman.

For every maintenance department

1 mechanical engineer or maintenance foreman and
2 fitters with good knowledge of the plant are on call for the time of one week after the normal working time and during weekend.

A few years ago an apprenticeship scheme for chemical plant operators was launched in Austria. After the normal education at school (normal age is 15 years) a young person can join e. g. Chemie Linz and can learn this profession for 3 years. During this apprenticeship at school, workshops and different plants the person becomes familiar with small maintenance jobs. Therefore in Chemie Linz the operators are allowed to carry out certain maintenance jobs under supervision of the production foreman and on the production department's responsibility.

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Maintenance jobs allowed for operators are listed below:

Mechanical jobs allowed for operators in department ...

After order and instruction by the shift foreman the following jobs are performed by production side after relevant guidance by the maintenance side in the units later mentioned.
Beside general precautions, the following particular safety instructions have to be considered:

Pipes and pumps are to be depressurized and drained, hand wheels of valves - if required - are to be locked, blinds have to be installed, switches for motors are to be locked or fuses are to be removed by the electrical department. For jobs with aggressive media the common safety means (e. g.: goggles, protective suits, rubber boots, gloves, etc.) have to be used. Flight devices or masks are to be kept ready, also water in form of a flexible water tube. If NO, SO2, CO/CO2 or other dangerous gases excape, the working area has to be left immediately.
In principle all jobs are to be carried out in such a way that neither the worker nor his surrounding will be endangered.

For all jobs for which a work permit was required up till now a work permit is also necessary in future (see safety instruction no. 6 - maintenance jobs in the plant).

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General instructions for all jobs

1. Do not use wrench extensions to tighten screws.
2. Tighten nuts or flanges and lids crosswise and uniformly.
3. Clean sealing surfaces before installation of new gaskets. Treatment of gaskets before use:
   for steam, cold water, hot water, air, sulphuric acid, lye: mixture graphite+ oil;
   for nitric acid, NPK slurry, ammonia: silicon grease
4. Only use undamaged bolts of sufficient length in the required quality and use undamaged nuts. Grease before use.
5. In the case of changing armatures pay attention to material pressure range and flow (arrow).
6. The general allowance to fulfill maintenance jobs is limited by normal pressure 10.
7. Welding jobs are not allowed.
8. To erect scaffolds higher than 1.5 m is not allowed (call scaffolders).

Gasket materials to be used

Steam, water, condensate, cold gases, compressed air, lyes	Klingerit 400 UNIVERSAL (blue) or Klingerit red
Phosphoric acid	Rubber reinforced by fabric
Nitric acid	Klingerit 400 or Klingerit Acidit
Sulphuric acid 99%	Klingerit red or Teflon

Sulphuric acid below 76%, H_2SiF_6	Klingerit Acidit or Klingerit red
Oils, coating agents	Klingerit oilit or Klingerit red

Beside the already mentioned general jobs for every unit of the department particular jobs are listed up which are also allowed to be performed by production personnel:

Some examples:

Bagging and shipping (unit 629)

Greasing of vehicles (dumpers, fork lifts, wheel loaders)	WOWP
Bag welding machines: Turn or change of razor blades	
Clean the filters of the vacuum pump	
Equalize felt disk	
Clean preheater and pre-pressing device (grease with silicon oil)	WOWP
Replace tubes	
Check and clean cooling water filters	
Adjust ammeter for heater	
Loading of accus	WOWP

Central raw material storage (unit 631)

Change armour plates on conveyor chutes	WWP
Repair small defects on belts	WWP
Change shear bolts on reclaimers	WOWP
Replace grease nipples and grease tubes	WWP
Clean oil pneumatic hammers	WOWP
Replace rubber aprons and belt cleaners	WWP

TYPE OF JOB	REMARK
Sealing glands on valves and pumps up to PN 10, small jobs on steam, condensate and warm water lines up to 7 bar.	Tighten screws equally. Lantern rings should not touch the shaft. Be sure that all screws are in good condition. "Klinger" valves are allowed to seal only in closed position. (with work permit)
Remedy leakages on armatures (e.g.glands,flanges of pipes) immediately after depressurizing and drainage.	Pay attention to general precautions, be sure that pipes are empty, wear protective clothes (with work permit).
Changing small valves and armatures(e.g.condensate traps) up to ND 100 and up to an operating pressure of 10 bar.	
Connection and disconnection of flexible tubes for compressed air, oil, water, acid as well as mounting of clamps	Use tubes only if clamps are mounted. Pay attention that the right tube couplings and reliable clamps are used (without work permit).

Setting and removal of small blinds (without groove) as well as connection and disconnection of corresponding pipes.	Pay attention to general precautions, depressurize and drain the pipes, use protective clothes. If electrical connections of earthings are to be disconnected inform electrical department before starting the job (with work permit)
Opening of lids for cleaning of vessels, hoppers, pipes and chutes. Provisional sealing of steam, condensate, acid and water pipes by means of clamps.	Use required protective clothes (with work permit).
Connect and disconnect oil, acid and other wagons or tankers without using threaded clamps.	Pay attention to safety instruction no. 23 - loading of wagons - and no. 28 - safety in the field of shunting (without work permit).
Refill and adjust drop-oilers as well as checking existing central-lubrication devices for functioning. Refilling grease pots.	Use only non-contaminated grease of prescribed type. Exception: central lubrication of filter in NPK plant will be maintained by the maintenance personnel (with work permit).

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Take care for all points to be lubricated e. g. nipples, grease boxes, oil droppers (on compressors). Exception: all closed lubrication systems (gear boxes,....)	Consulting lubrication chart. Exception: grease nipples and grease boxes in NPK plant (without work permit).
Help for lubrication of running pan-conveyors by means of a motor-grease-press.	One man stands in visual contact with the greaser on the emergency switch of the conveyor (with work permit).

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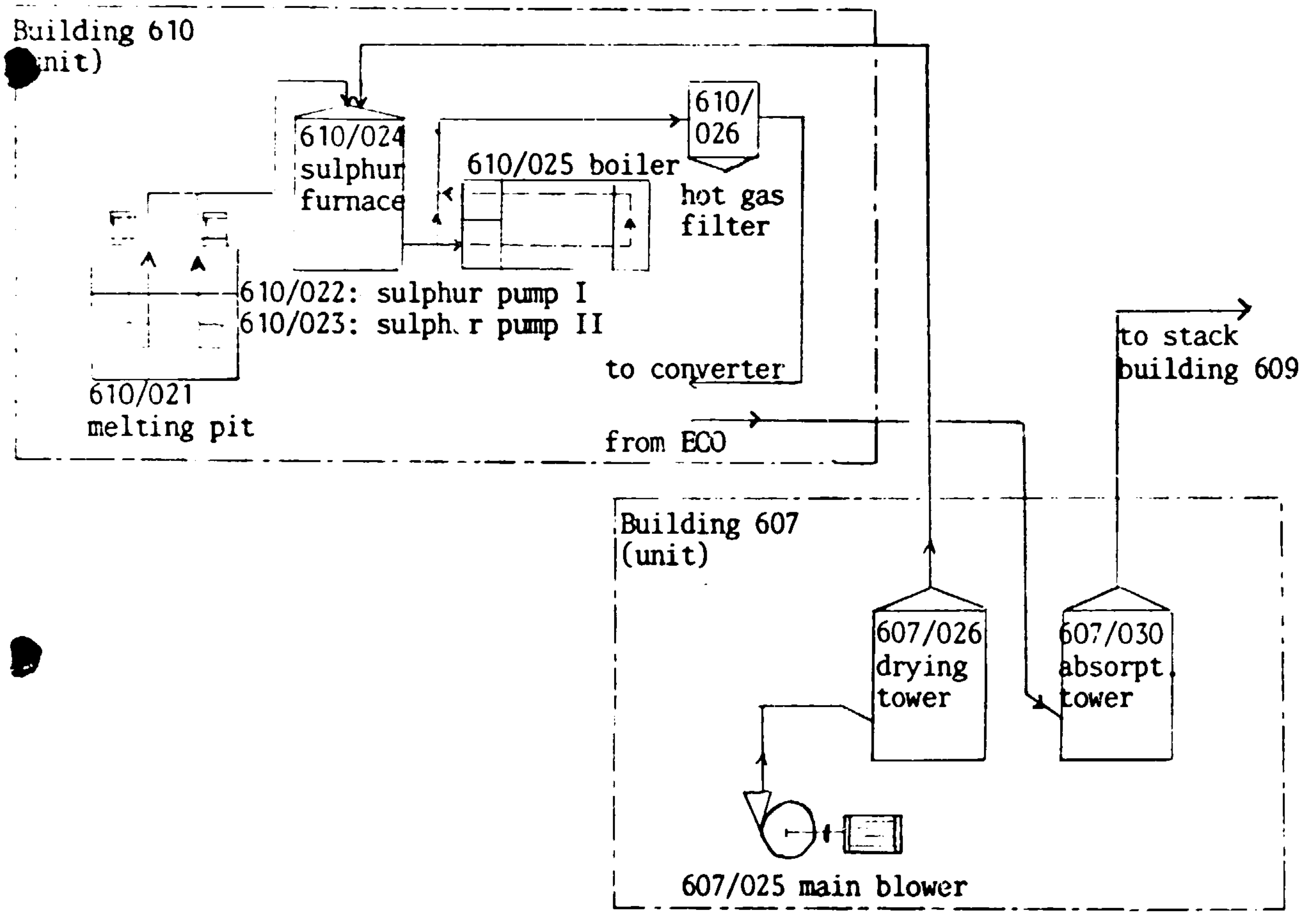
INVENTORY SYSTEM OF CHEMIE LINZ AG



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Each building in the company has a separate number. For administration buildings the numbers 1 - 99 are reserved. For the different buildings in the plants the numbers 100 - 999 are in use. Each machine and apparatus has an apparatus number (e. g. 610/024 - sulphur furnace of Monsanto plant). The first three figures mark the unit in which the machine is in action.
The second three figures determine different machines in a certain unit (building). Electrical motors are separately numbered and inventoried by the electrical department. All machines and motors in the field and the replacements in stock are marked with the apparatus number.

Example of inventory record

610/021 Sulphur melting pit, 21 000 x 4 300 x 1 500 mm, with coils and agitator.
Three phase current motor, 5.5 kW, 1 400 RPM, gear transmission to 84 RPM, motor number 693970

610/022 Sulphur pump, vertical type, size 1¼, VSO - 861 - 1/4, temperature of molten sulphur 135oC Fa., Lewis & Co TPC motor, 4.8 kW, 2 870 RPM, motor number 694200

610/023 Sulphur pump, equal with 610/022
TPC motor, 4.8 kW, 2 870 RPM, motor number 694201

610/024 Sulphur furnace, vertical construction, 3130 Ø x 7750 high, steel shell, brick lined, manufacturer: Reisner & Wolff

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610/025 Waste heat boiler, 1 800 Ø x 7 600 long, 225 m2 surface, 16 kp/cm2 steam pressure, insulated, regi-number 2236, boilerfeedwater-drum 1500 Ø x 5000 long, 10 m3 volume

610/026 Hot gas filter ......

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SALARY SYSTEM - LEAVE

In Austria there is a collective agreement between the Federation of Trade Unions (labor unions) and industry. At intervals of 1 to 2 years the two parties fix the wage increases for a certain period.

In Chemie Linz AG there is a special system called "Salary regulation". Our salary is calculated as a sum of four groups:

1. Basic salary (BS)

   It depends on the position of the employee. The scale of basic salary is divided into 23 steps.

2. Seniority value in percent of the basic salary (SV)

   $$SV = \frac{67 \times \text{years of service with Chemie Linz}}{90 - \text{entry years (age)}}$$

3. Experience value (EV) in percent of the basic salary.

   This value is 1% per CL service year up to a maximum of 18%.

4. Personality value (PV)

   It depends on the opinion of the employee's supervisor and increases from 0 to 33.6%.

<u>Monthly salary: BS + SV + EV + PV</u>

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Holiday (leave credit)

Up to 20 service years:	24 week days (4 weeks) Mo - Sa
More than 20 service years:	30 week days (5 weeks) Mo - Sa

Years of study are credited as service years to the following extend:

Charge for Technical High Schoold:	3 years (duration of school: 5 years)
Charge for Technical University:	5 years (duration: 5-8 years)

More than 25 Chemie Linz service years:	30 actual working days (6 weeks)

Additional freetime

for marriage, birth of a child, moving house, death of relations in the amount of 1 to 3 days.

Recreation leave in company-owned hostels

Every 21 months:	Production and maintenance personnel in very dusty and dirty areas.
27 months:	Foremen and workers, laboratories
37 months:	Employees in production offices
96 months:	Employees in administration offices

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WORKING WEEK

In Austria the 40 hour week is generally worked.

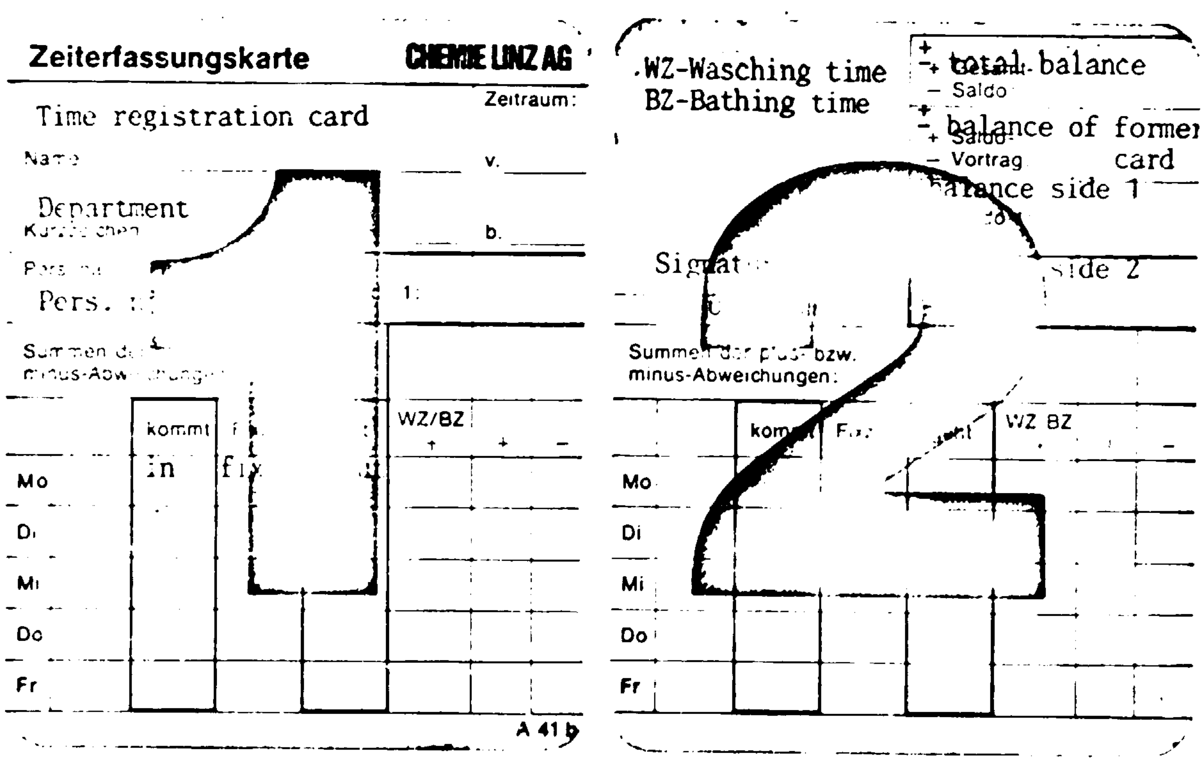
General shift

Flexible working time:

start in morning:	6.30 till 8.30 h
	3/4 hour lunch break
close in afternoon: Mo - Th:	15.30 till 17.30 h
Fr:	12.30 till 14.00 h

Recording of actual working time on "time registration cards".

front side | back side



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The maximum plus or minus balance allowed for one complete registration card is 10 hours. Employees of Chemie Linz AG can take two free mornings or afternoons or one free day per month if they do not infringe the 10 hour limit and if their superior gives his consent.

Shift system

Most of our plants are on stream 24 hours per day. For these production lines in the different departments there are 4 shift groups working 8 hours per day according to a shift table. These groups also meet the 40 hour week with temporally fixed free shifts.

Examples of different shift systems:

		A	B	C	D	
2 shift groups A, B	Monday-Friday	6-14	14-22			bagging and loading
3 shift groups A,B,C	Monday-Friday	6-14	14-22	22-6		superphosphate
4 shift groups A,B,C,D	the whole week	6-14	14-22	22-6	free	most production plants

SUGGESTION SYSTEM

In 1953 Chemie Linz AG introduced a suggestion system.

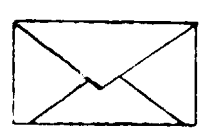
How to make a suggestion:

1. The idea

Everybody can make suggestions. The office "Suggestion System" and the members of the works council will help composing a suggestion.

2. Presentation

Possible via the superior, the office of suggestion system or the works council. One can also put the proposal into the "suggestion letter box".

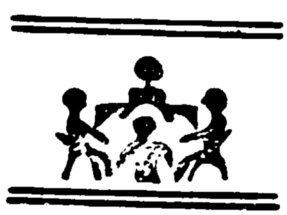


3. Registration and examination

The office checks the suggestion formally and asks for the opinion of one or more experts.

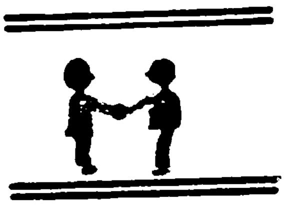
4. The decision

Acceptance or rejection of suggestions is the duty of a "suggestion commission".



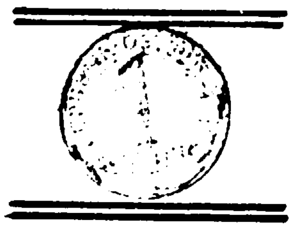
5. Reward

The experts calculate the annual savings and suggestion commission has to fix the reward.



6.Payment

If the suggestion is worth while the employee will get the reward together with his/her monthly salary.



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We distinguish estimable and computable suggestions. An estimable suggestion can be rewarded with AS 200,-- up to AS 3.000,--, depending on the result of the evaluation system.

Criteria in the evaluation system:

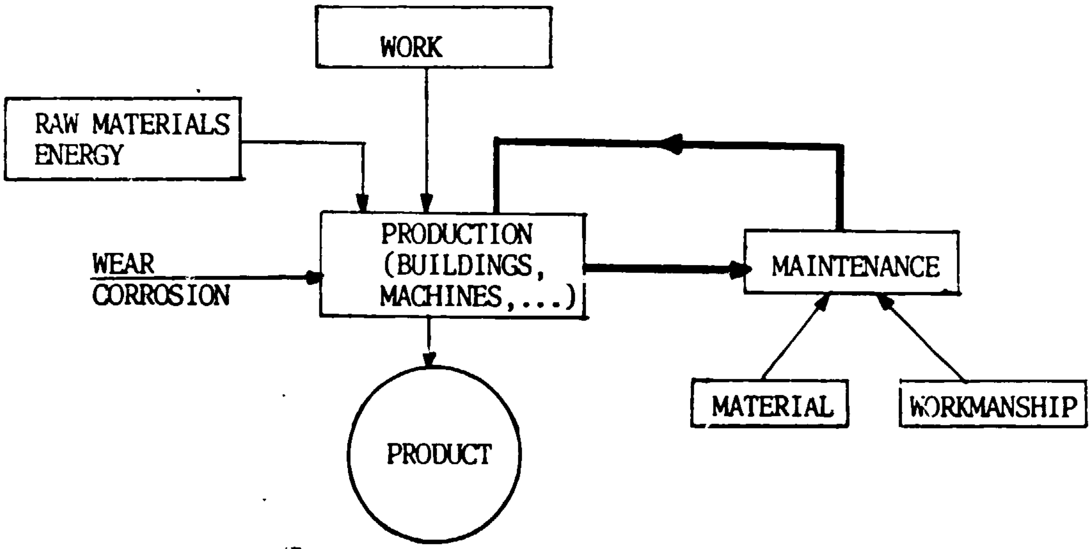
Importance	important	negligible
Kind of solution	original	already used
Effect of the proposal	complete change	insignificant change
Frequency of application	often	single
Site of suggestion	own business	foreign business
Elaboration	practically tested .	not tested
Realization cost	up to AS 3000,-.....	more than AS 5 000,--

LECTURE

FUNDAMENTALS OF MAINTENANCE

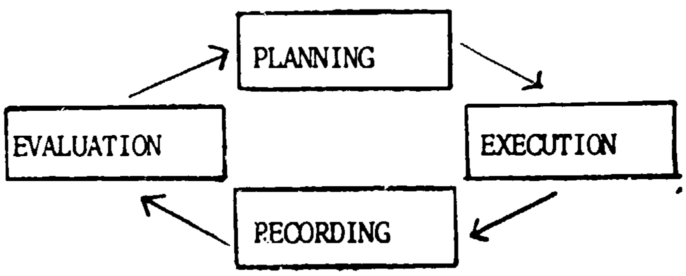
1. Production and maintenance

Position of maintenance in a production process:



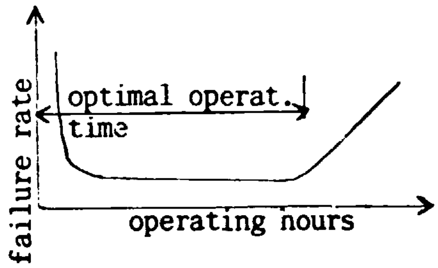
2. The maintenance cycle

2. The maintenance cycle

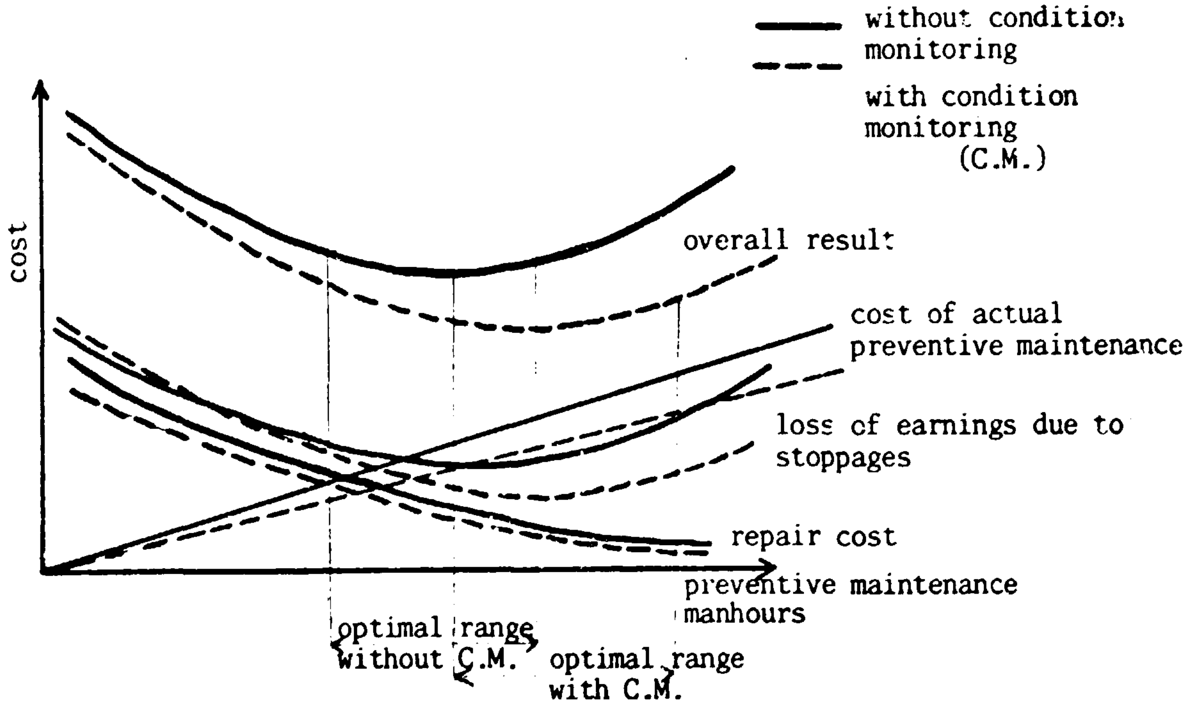


3. Some technical items

Administration
Preventive maintenance
Corrective maintenance
Modification
Replacement
Direct preventive maintenance
Indirect preventive maintenance
Subjective inspection
Objective inspection
Surveillance
Bath tub effect



4. The economic effects of preventive maintenance



5. <u>Maintenance costs</u>

Wage costs

Material costs

Administration costs

Purchased services

Conversion costs

Direct maintenance costs

Indirect maintenance costs

6. <u>Maintenance in a production process</u>

a) Operation	Duties of a production department
b) Control	
c) Care	
d) Maint.	
e) Check	
f) Repair	Duties of maintenance department

7. <u>Maintenance and internal organization</u>

8. <u>The man in the maintenance process</u>

9. <u>Wear - reason for maintenance</u>

Wear

Corrosion

Fatigue

Ageing

Kinds of wear:

10. Wear and corrosion phenomenona

a) even and scared corrosion

b) pitting

c) intercrystalline corrosion

d) transcrystalline corrosion

e) layer corrosion

f) bacterial corrosion

g) crevice corrosion

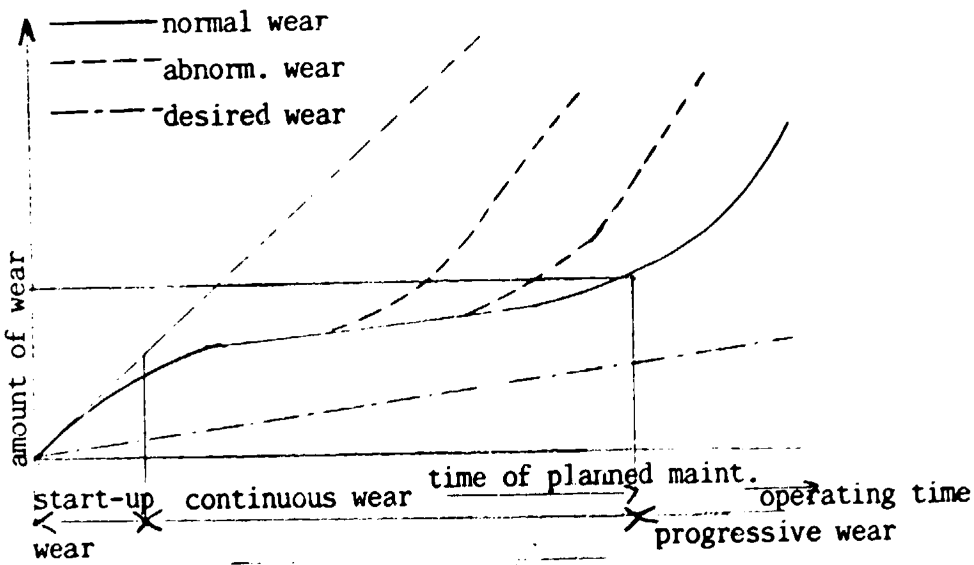
h) fatique

i) ageing

k) thermal influence

11. Types of faults

12. Registration of wear processes

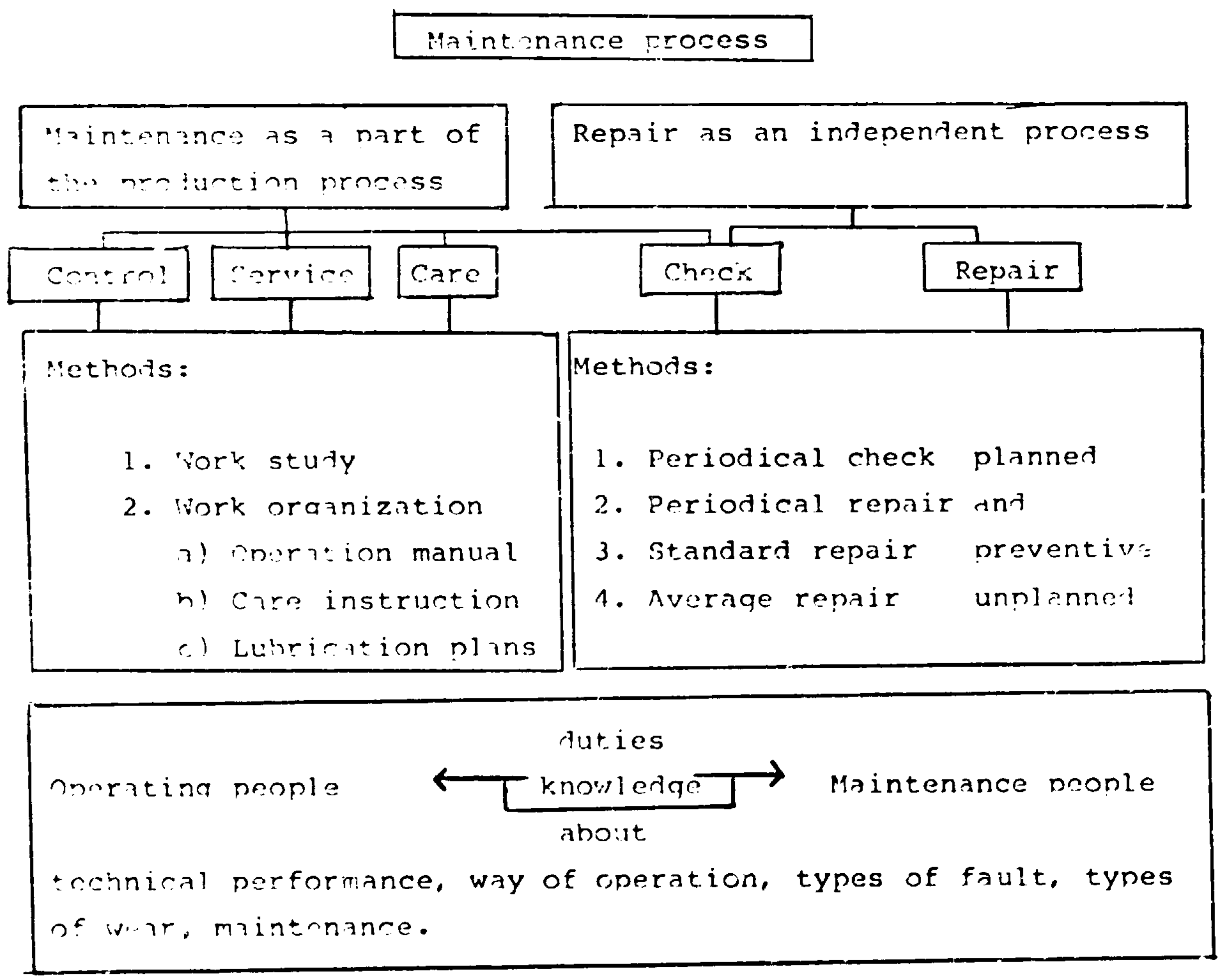


13. Defence of wear

14. a) active and b) passive protection against corrosion

a) avoidance of destruction
b) formation of a protective layer

15. Technology and methods of maintenance



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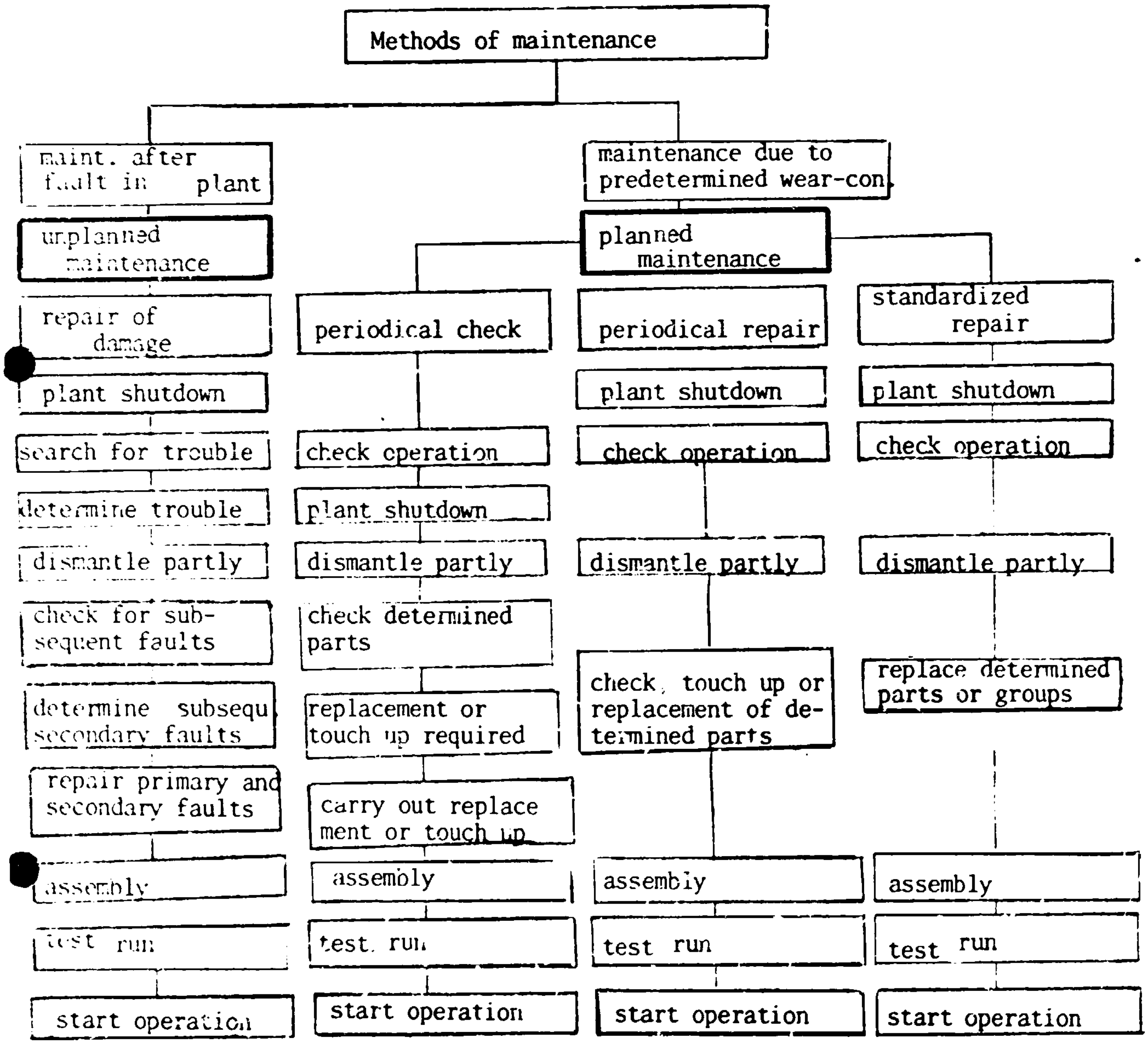

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16. Repairs

17. Maintenance schedule

18. Preparations for maintenance

19. Maintenance
Management - Planning - Realization

20. Demand for repairs

21. Investigation fo repair material

22. Planning and account control of maintenance

23. Specialization according to machines used

Buildings
Civil facilities (streets, sewage, ...)
Vehicles
Hoists and conveyors
Machine tools
Tubes
Pumps, compressors, turbines, ...

24. Surveillance and maintenance in chemical plants

25. Maintenance and pollution control

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Beside the legal rules and directions, some other

SAFETY INSTRUCTIONS

exist in Chemie Linz AG

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1. General instructions: competence, foundations, smoking prohibition, alcohol prohibition, maximum speed inside the area of CL, first aid performance, safety advice,...
2. Information procedure on fire-brigade actions and accidents
3. Fire-brigade operations
4. Alarm routes for the fire-brigade
5. Safety measures
6. Maintenance business
7. Local extinguishers
8. Use of protective hoods
9. Entering vessels
10. Foreign company workers in the plant
11. Protective equipment and protective clothing
12. Safety instructions
13. Scaffolding, ladders
14. Storage of combustible materials
15. Use of solvents
16. Radiation protection
17. Portable electric hand tools (power tools)

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18. Directions and marks for safety work
19. Responsibility for repairs on pipeline bridges
20. Bolt shooting devices
21. Directions for chemical labs
22. Aparatus, devices and equipments prescribed for inspection
23. Loading work on waggons
24. Transporting tanks
25. Glass carboys (balloons)
26. Steel bottles
27. Pressure vessels
28. Safety on railway lines
29. Guided plant tours
30. Vehicles without rails (fork lift trucks, ...)
31. Alarm plan for special departments
32. Fire protection in glue plant
33. Reporting industrial accidents
34. Transporting prussic acid

Yearly check on all continuous conveyors (belt, chain conveyors etc.) and notice of the inspection in a check book.

Yearly earthing check on tanks for combustible materials.

Control of the lightning conductors at intervals of two years.

The items underlined will be discussed in detail.

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Safety instruction 6

MAINTENANCE IN THE PLANT

All jobs in connection with maintenance, erection, servicing, manufacture etc. on or for equipments of plant must be approved by a person responsible for this plant before work starts. This is done by a written "APPROVAL SHEET" for repair work (see sheet A 79 b), signed by the leader responsible for the particular area or (in place of the leader) by a person who is made responsible by the manager of the department.

The approval sheet is valid only for one particular job.

Minor jobs with no element of risk are allowed without an approval sheet. Arranging the job is the responsibility of ordering (production foreman) and performing department (maintenance foreman). The issuer of the approval sheet and the job performer are responsible for using all appropriate protective measures before and during the service job. In principle this approval sheet shall be for all people concerned with the service job

1. a memory aid
2. avoiding misunderstanding between ordering and performing side
3. exact determination of precautions
4. clearly allocated responsibilities

The approval sheet has to be signed before the job is carried out by the technical side. The original (yellow) of the approval sheet is kept by the work executing side, the copy (white) remains with the issuer.
If the repair is performed by personnel from other workshops (THW, TBW, ...) the foreman of the other workshop gets the approval sheet after instruction from the technical (maintenance) side of the plant and the other workshop confirms agreement to the ordered precautions by signature. Beside this, special means of course all the specific instructions for the technical work must be observed. These specific instructions are not written on the approval sheet.
After finishing the job the responsible person of the executing workshop fills out the tear-off-part of the yellow original sheet with time, date and signature and hands over this part to the issuer. The issuer sticks the tear-off-part to the white copy (specimen) of the approval sheet.

Because a test run is necessary after finishing the repair, the responsible maintenance man fills out the rubric "SWITCH TOTEST RUN" with time and date, and signs it. The foreman of the plant workshop also signs this column and arranges the start of the machine with the production foreman. During the test run the approval sheet (yellow) is on the production side.
After due performance of the test run, the approval sheet comes back to the repair foreman, who signs the rubric "JOB FINISHED", and the tear-off-part is handed to the issuer as described above.

If it is not possible to finish the repair on the same day, an application must be made for extension of approval. Therefore the issuer has to write a note on the yellow sheet, duplicated on the white copy.

To simplify filling in approval sheets and fixing precautions, special supplements in which the danger and the required precautions are indicated are provided.

Long-term approval sheets for routine jobs can be issued for a time limited to one year after consulting the safety engineer. The required single approval sheets before performance of work concerned are issued on their own responsibility by the deputies of the responsible person (foreman), based on the long-term approval sheet.

The observance of the ordered safety instructions by the executing people is checked by the competent supervisor.
Approval sheets for entering sewers and purification pits must also be signed by the safety department.

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Safety instruction 13

SCAFFOLDING, LADDERS

For erection of scaffolding during execution of civil works Par. 19 - 33 of the order about "protection of workers and employees" and the standard "OENORM B 4007 - scaffolding" Par. 35 - 37, and ÖENORM F 5120, concerning ladders apply. Ladders to be inspected according to safety instruction 20.

During erection and working on scaffolding the following procedure is obligatory: of the various scaffolds are erected by the civil department as per order sheets (form A 99). The original of this sheet is sent to the civil department from the orderer, one copy together with the order for dismantling of the scaffold remains with the orderer, and one copy goes to the safety engineer. The safety engineer has the possibility to receive safety interests on time.

In all cases where the civil department has a permanent work order for erecting scaffold the number of the permanent work order must be written on the order for erecting a scaffold. Therefore no separate work order is required. If there is no permanent work order by civil department beside the order for building a scaffold also a work order is required for accounting the workmanship. The sheets are arranged so that both parts can be written as copies. Work order and scaffold order must be handed over to the civil department. The determination of workmanship in each case is to divide in : exact place, aim of the scaffold and required load capacity in kgs.

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The orderer takes over the scaffold by signing the relevant scaffold order (scaffold taken over). Looking after the scaffold and maintaining it in good condition till now is the duty of the orderer.

He has to check continuously. He is not responsible for proper and correct erection, which is the exclusive duty of the scaffolders. But taking over department is responsible for the satisfactory state of the scaffolding.

To avoid the improper use of scaffolds which are not ready or have not been taken over yet, the civil department has to mark them by a sign: "Don't use scaffold". When the scaffold are taken over these signs are removed.

If a scaffold is no longer in use, dismantling of the scaffold must be ordered with sheets 3 - 5 of form A 99. Immediately after starting to dismantle, the civil department fixes the plate:"Do not use scaffold" on the scaffold. Afterwards the scaffold must be removed promptly.

Concerning double wooden ladders as per OENORM F 5120 steel ropes with a diameter of 4 mm must be used instead of chains to avoid the two beams moving (see safety instruction 20).

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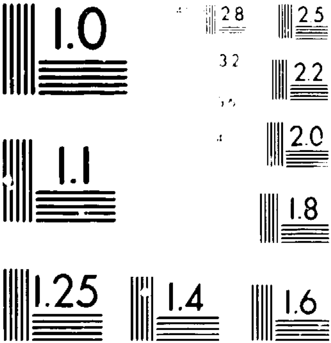

MICROCOPY RESOLUTION TEST CHART

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Safety instruction 17

MOVABLE ELECTRIC HAND TOOLS AND MOUNTING LAMPS

To define the required precautions and in the interest of good cooperation with outside companies and workers from outside companies, while complying with OEVE instructions E 1 and E 40, the following precautions are ordered:

Movable electric hand tools

1. For jobs in vessels, containers, tubes and similar small equipment of good conductive material and for jobs on such equipment with comparable narrow place conditions.
2. Jobs on metallic conductive points such as grids and steel constructure.
3. Jobs on good conductive points (soil, concrete).
4. For jobs on poor conductive points such as workshops with dry and non-metallic floors, offices, dry tile floors.

It is also pointed out that disconnecting transformers must be located outside the dangerous rooms and only the connection of one electric hand tool is allowed.

A supplement shows different kinds of electric hand tools and permissible uses.

UNFALLANZEIGE

ACCIDENT NOTICE

… des Allgemeinen Sozialversicherungsgesetzes (ASVG), BGBL. Nr. 189/1955 …
… Tod oder mehr als drei Tagen Krankenstand. Die Meldefrist beträgt fünf Tage!
… drei Exemplare einsenden! Der weiße Durchschlag ist für Ihre Firma bestimmt.

Firma, Anschrift (Betriebsort), Postleitzahl, Art des Betriebes company address	2 Zahl der im Betrieb beschäftigt. Personen number of employees
Familien- und Vorname des Versehrten (in Blockschrift) full name of injured person	4. Versicherungsnummer insurance n°. / 5 geboren am date of birth
Anschrift address	7. Staatsangehörigkeit citizenship / 8 Gastarbeiter foreign worker ja ☐ nein ☐
… im Betrieb seit … Anlernung working as skilled ☐ semi-skilled ☐ angelernt ☐ unskilled Hilfsarbeiter ☐	10. Fam. Stand family status / 11. Anz. d. Kinder unter 18 Jahre number of children
Name und Dienststellung des zuständigen Vorgesetzten name and position of competent superior (superiors)	14. Vorgesehene(r/s) Arbeits– Beginn Ende planned start of work
… Krankenkasse … Kontonummer health insurance fund concerned	manual worker ☐ office worker ☐
… (Arbeitsunfall, Berufskrankheit, Wehrdienstbeschädigung, Invalidität, Opferfürsorge) mit Rentenbezug von previous injuries	
Unfallstelle im Betrieb (z.B. Stanze, Bohrmaschine, Kran, Aufstellungsort und Fabrikationsnr.) place of accident in the plant	18. Wochentag Datum Uhrzeit des Unfalles weekday/date/time of accident
Wenn nicht ident mit Betriebsanschrift: Genaue Anschrift der Unfallstelle (Ort, Straße, Hausnr., Bundesland) if not identical with company's address: exact address of place of accident	20. Arbeit eingestellt am / Uhrzeit work finished date/time
Verletzte Körperteile und Verletzungsart injured part of body and type of injury	22. tot dead yes ja ☐ no nein ☐
… Krankenhaus eingeliefert? An welchem Tag? to which hospital taken? which day?	24. Erste Hilfe im Betrieb? ja ☐ nein ☐ first aid in the plant
Erstbehandelnder Arzt, derzeit behandelnder Arzt (Name und Adresse) name and address of physician treating patient first/currently	
Schilderung des Unfallherganges, so daß sich jedermann ein klares Bild machen kann. (Arbeitsverrichtung und Unfallursache, eventuell Art der beteiligten Fahrzeuge) description of the accident - in simple words everyone can understand	
Bei Wegunfällen: Von wo ist der Versehrte weggegangen? Wohin sollte er sich begeben? accidents on journeys: routs of injured person: from - to	
Unfallzeugen (Name, Anschrift) witnesses of the accident	29 Arbeit wieder aufgenommen am resumed on work
Erhebung durch Polizei oder Gendarmerie? Dienststelle? statements taken by police?	
Welche Maßnahmen werden getroffen, um künftig ähnliche Unfälle zu vermeiden? What measures will be taken to prevent such accidents in future ?	32 Ort, Datum place and date CHEMIE LINZ AG Firmenstempel, firmenmäßige Zeichnung

U – Nr.

DVR 0024163

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PRODUCTION CONTROL

I. Introduction

Since price developments and availability are continually increasing the significance of the cost factor energy plus raw materials, every firm is forced to give the associated issues in-depth treatment.
However, the goal of maximum cost effectiveness can only be rached if suitable records of generation and consumption are available on the necessary scale, and when these are worked through by a selected team. Larger firms will have their own staff for this; small firms should consider making use of outside energy consultants.

At Chemie Linz AG it was realized right at the beginning, i. e. immediately after the second world war, that the use made of energy and raw materials needed to be continually recorded and monitored, and critically assessed.
To take care of this a department was formed with responsibility for all production sectors and all forms of energy; its aim is to achieve the maximum cost effectiveness mentioned above.

As the area of responsibility has been extended to include various aspects of general interest within the firm, the department now reports directly to the directors; it has the following structure:

- safety engineering services
- fire fighting
- energy and raw material control
- pollution control

This paper is concerned exclusively with the responsibilities of the team concerned with energy and raw materials in connection with production control.

A)Organization and structure

To cope with the extensive statistical material and the complexity of the problems presented, the following distribution of tasks has established its worth in practice:

1. Billing center and day-by-day accounting (4 people)

Covers: data collection and evaluation
data bank input via teminal
general and specific computer programs for energy and raw material flows
calculating daily production for main products

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2. Data bank and month-by-month accounting (4 people)

Covers: calculating monthly data for all production sectors and all types of energy
splitting up and allocating the various types of energy for calculation purposes
computer program maintenance
generating various forms of information required for assessing energy and raw material consumption (e.g. specific data)

3. Monitoring and assessment (7 people)

Covers: continuous and retrospective monitoring and assessment of energy and raw material consumption and losses (yields) monitoring and optimizing production sequences and energy equipment; inspecting pipe network
handling purchases of energy from outside sources (electricity, gas)
producing mathematical models of production
advance planning for production, energy and maintenance

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4. Production supervision center (10 people)

The supervision center is a permanently occupied, central coordinating and information facility, concerned with:

- monitoring current energy consumption, with particular attention to line-bound forms of energy
- guiding energy consumption as regards peak consumption
- continually observing and recording activities in the main production sectors
- permanent contact with outside energy suppliers initiating countermeasures when faults occur

B)Staff and equipment available

To deal with the range of responsibilities outlined above, 25 people are employed, 6 of them with a technical qualification. The complexity of the problems make an excellent knowledge of the plant and technical, chemical and commercial understanding necessary. As all accounting procedures and most control functions are handled via EDP equipment, the majority of the staff have a training in data processing. Within the various teams 3 terminals with display screens provide technical support; these are linked to the main Chemie Linz computer. Calculators, tables and graphs are also used. Planimeters are employed to evaluate plotted data. The production control use 2 load flow monitor devices to check consumption of natural gas and electricity (peak values) continuously.

These devices are computerized, and display meter data and consumption trends at terminals. Meters and flow recorders are also available to provide a continuous check of the consumption of other media.

C) **Extent of monitoring activity**

In principle all media required in the plant are monitored: natural gas, fuel gas, fuel oil, electricity, steam, boiler feed water, condensate, river water, drinking water, compressed air, nitrogen (for purging) and pilot air.

These media can be monitored effectively only if the generation process and the various consumers are continuously covered. The large number of consumers make it impossible to allocate consumption on a day-to-day basis;; as far as auxiliary media are concerned, therefore, we limit ourselves to monthly accounting.

Full day-by-day accounts are used for natural gas as a primary energy resource and raw material.
The generation of the various media is treated in the same way (day-by-day).

Primary production (ammonia), the products derived from this and the main forms of energy and raw materials involved are also worked out on a day-by-day basis.

These dayly/monthly data for consumption and production are pro-cessed by means of various computer programs to calculate specific characteristic data. These characteristic data are catalogued; in conjunction with various other production data (pressures, temperatures, compositions, yields, efficiency factors, etc.), they serve as a basis for assessment ("Specific value folder"). Deviations from typical values that cannot be explained in terms of special operating procedures are subjected to a special investigation.
If the need arises, the production department concerned and the instrumentation department will be called in.
It is possible to judge whether such operating data are correct only on the basis of comprehensive knowledge of the production facilities, the production sequences and potential causes of trouble.

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II. Description of activities

On I.A) 3: Monitoring and assessment

Monitoring processes and plant effectively and assessing them meaningfully presuppose an accurate, detailed documentation of all data connected with energy and raw material flows in production, matched to the individual circumstances. These statistics and a specialized knowledge of the links between energy consumption, raw material inputs, process engineering, plant loading and various technical and chemical facts are the basis for computations which reveal the type and locality of losses and the extent to which economies are possible. Knowledge of the initial situation (target values incorporated in the design, expansion stage reached, technological level) is a necessary precondition both for judging the current situation and for selecting successful economy measures in terms of the current situation.

One of the most common methods of monitoring consumption (also used at Chemie Linz) involves determining energy and raw material consumption data in relation to production on a daily and/or monthly basis, collecting statistics on all variables required for assessing process sequences (such as pressures, temperatures, compositions, chemical equilibria), and judging these numerical data critically.

Another promising method of identifying losses resulting from the use or conversion of raw materials and forms of energy is to draw up material flow and energy input/output diagrams.

Energy flow diagrams provide a way of detecting the amounts of energy not used in one installation and given off in the form of heat, while free enthalpy diagrams are of greater help in determining their value and the extent to which they can be reused in other processes.
Material flow diagrams and comparisons between quantities produced and consumed make it easy to determine material losses quickly.
Depending on the extent to which savings in primary forms of energy are to be anticipated, and on how complicated the process in question is, a rough analysis of the steps in which the largest losses can be presumed will be adequate in some circumstances.

Continuous consumption monitoring is aimed at the following tar-gets:

- reducing energy and raw material consumption, thus making the products in question cheaper

- extracting a few characteristic data of real significance from a large quantity of disorganized process information

- elucidating numercial data on the connections and interrelations between the process variables in a production process

- identifying the structure and limits of the various influences

- predicting consumption values in relation to changes in the pro- cessing sequence (optimizing)

- motivating employees to economize on the use of energy

- constructing diagrams for monitoring the state of an installation as regards possible causes of loss
- issuing representative data on energy and raw material flows for the benefit of top management and production departments.

Natural Gas

a) Introduction

Chemie Linz AG uses approx. 550 million cubic maters of natural gas per year, i.e. around 14% of the entire Austrian consumption. Roughly 90% of our consumption is used to generate ammonia; the remaining 10% are consumed in firing and drying systems.

The natural gas is supplied by the agency responsible for the Austrian province in question, Oberoesterreichische Ferngas, who are also responsible for delivering the gas as far as the point of transfer (metering device owned by the suppliers). The business details connected with gas purchase are fixed in a supply con-tract.
In Austria the price of gas is regulated by a public commission which lays down price ceilings for the various provincial agencies in the light of circumstances.

b) Method for determining the quantity of natural gas to be invoiced

The way in which charges are made for natural gas varies greatly from one gas supplier to another. Consumption is basically measured in cubic meters. In the case of small consumers, parti-cularly where they are supplied from a gas mains at low pressure, consumption is indicated in operating cubic meters, whereas in the case of larger consumers supplied at high pressure the quantity measured in operating cubic meters is converted to standard cubic meters (at 0oC, 1013.25 mbar) by a conversion device. If no conversion device is on hand, the conversion factor F is calculated on the basis of the pressure and temperature obtaining as follows:

$$F = \frac{273.15}{273.15 + t} \times \frac{b + P}{760} \times \frac{1}{K}$$

e.g.:

$$F = \frac{273.15}{273.15 + 10} \times \frac{740 + 15001.2}{760} \times \frac{1}{0.98} = 20.3883$$

b = barometric reading in mm Hg e.g. 740 mm Hg

p = gauge gas pressure in mm Hg e.g. 20 bar gauge
(1 bar = 750.06 mm Hg)

t = gas temperature e.g. 10oC

K = compressibility factor as per table e.g. 0.98

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or

$$F = 0.269578 \times \frac{P}{T} \times \frac{1}{K}$$

e.g.:

$$F = 0.269578 \times \frac{20986.5}{283.15} \times \frac{1}{0,98} = 20.3883$$

where

P (bar) = bar (gauge) x 1000 + Ba (mbar)

or

P (bar) = p (gauge atmospheres) x 980.665 + Ba (Hg) x 1.333223

T = t + 273.15

The resulting natural gas consumtion, now expressed in cubic meters at standard temperature and pressure, is converted by some suppliers into a quantity of heat, taking the gross calorific value into account.

As far as gas sales are concerned, changes in the Austrian law on measurements and calibration which came into force on 1973 01 01 give preference to charging on a kWh basis.

Below various methods of invoicing for natural gas in use at various suppliers' in their dealings with special category customers are summarized:

- Consumption is invoiced by standard cubic meters; only a working price per standard cubic meter is charged. If consumption drops below a defined load factor, surcharges are made for gas storage chemserv CONSULTING GES. M.B.H.

- Consumption measured in standard cubic meters is converted into kWh on the basis of the calorific value. Apart from charges for a working price, an energy price per MW is charged for an agreed amount of power per hour or day. The energy price level depends on the pattern of consumption

- Consumption is measured in standard cubic meters. Both a working price per standard cubic meter and a fixed availability charge per month are invoiced. Monthly consumption in the months
October to May over and above peak monthly consumption in the months June to September is invoiced at a higher rate per standard cubic meter

C) **Natural gas metering equipment**

Since natural gas is used as a raw material and a fuel on a large scale in the chemical industry, while its price makes it the most significant cost factor, great attention is paid to accuracy in metering. The description of a metering system given below represents the current state of the art for a large consumer.

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The quantity of natural gas supplied is normally measured with volume meters; here both displacement meters and turbine-type inferential meters are in use. In exceptional cases orifices are employed to measure (usually extremely large) gas flow-rates. The instruments used are required to be calibrated, i.e. a public body checks the accuracy of measurements. Instruments are released for use only if the inaccuracy detected lies within a prescribed margin - currently +/- 2% between 0 and 20% and +/- 1% between 20 and 100% of rated load.

To convert the volume measured under operating conditions by the gas meter to a standardized volume (273.15 K, 1.01325 bar), volume converters are used which also require calibrating. These converters measure the variables pressure and temperature with 2 independent transmitters, while taking atmospheric pressure into account. Converting is then done either mechanically or electronically; electronic systems offer various advantages, in-cluding greater accuracy.

Pressure and temperature must be measured separately, parallel to the instrumentation described, partly so that a check can be made at any time that volume conversion is being done correctly, and partly to have the data for manual conversion available if the automatic converters break down.

It also turns out to be a good idea to record the volumetric flow on suitable plotters or to monitor it continuously on a display screen. This method has considerable advantages if extra charges are levied whenever the flow erises above a defined level per hour or day (peak monitoring).

d) Checking and monitoring the natural gas metering system

In view of the considerable sums that change hands on the basis of metering natural gas flows, it is extremely important to monitor and check the instrumentation continually.
The most reliable and accurate method of checking - but also the most expensive - is to install a second flow metering unit (master meter), connected up so that it can be switched in series to the device to be tested, while gas does not flow through it the rest of the time. Comparing the 2 devices periodically will reveal any long-term changes in the precision of the unit used for invoicing. Fitting a control orifice provides a similar way of monitoring. However, an exact comparison of data is possible here only if the orifice is cleaned before every comparison, since even slight deposits can falsify the results obtained. Apart from these direct checks of the primary measuring devices, the converters also need checking regularly. To do this, the effective conversion factor F (standard cubic meters divided by operating cubic meters) is compared daily with the conversion factor a computer derives from pressure and temperature plots.

In addition to this continual checking to detect changes in conversion, the absolute correctness of the procedure must be checked periodically. Here the pressure and temperature transmitters for the converter are tested against a calibrated pressure balance or calibrated pressure gauge and a calibrated thermometer.

To monitor that the transport system, i.e. the distribution at work, functions correctly, daily volume accounts for input and output should be produced. These accounts also provide a way of checking that the instruments installed at the users' - usually orifice devices - function correctly.

e) Settling accounts with the gas supplier

Apart from continually monitoring consumption, instruments, distribution and allocation, the department responsible for energy and raw material flows also has the task of settling accounts with the gas supplier.
The volume consumed is paid for monthly, on the basis of the quantity measured as supplied each day. As invoicing is done on the basis of heat content in Chemie Linz AG's case, the calorific value of the gas must be registered parallel to the volume flow.

For this purpose the mean gas composition is worked out by analysis from a daily sample, and the calorific value of the gas supplied determined from this. Together with the flow volume registered, this provides the basis for invoicing.

Electricity

a) Introduction

The chemical industry can produce smoothly only if all production and ancillary facilities are kept supplied with electricity without fail. At Chemie Linz AG around 700 million kWh (GWh) are needed per year to generate and process ammonia and to produce a large number of other products. This makes our company one of the largest industrial power consumers in Austria.

To guarantee this massive consumption, a supply contract was con-cluded with the Oesterreichische Verbundgesellschaft (VG) several years ago. As nationwide supply organization, VVG operates the Austrian high-tension distribution network, and supplies the largest users in Austria.

The fact that Chemie Linz AG is connected up to VG' s 110 kV distribution network means not only that the supply of electricity is ensured, but also that a reduced price can be charged. As in the case of natural gas, the electricity tariff is determined by public bodies. As a large-scale electricity consumer, our company is continually at pains to reduce the amount of electricity it draws from the public supply system. In 1982 a facility was started up at our Enns works to generate electricity from waste heat; this supplies around 7% of the electricity we need.

b) Measuring equipment for accounting

In view of the large quantities supplied and the value of electricity, it is essential to measure consumption exactly. As a rule supply contracts with large consumers prescribe that the work consumed (kWh), the power taken (kW) and the reactive power taken (kVArh) must be measured. The supplier provides the necessary meters for active and reactive power, plus a device to register power (maxiprint). Large consumers are well advised to install a back-up measuring system; if it has the same technical characteristics, it can also be used for invoicing (deriving mean values).
What form the metering equipment in a metering station takes depends on how power is supplied to the company, and its location in the distribution network. Our metering station used to register the electricity taken from the network in Linz and Enns will serve as an example here (see schematic 1).

c) Checking, monitoring and settling accounts

In view of the large number of meters to be taken into account for settling accounts, and the resulting risk of faults, the readings of the summation meters and of the maxiprint meters are evaluated every day and compared. In addition, all meters are read every month and the readings checked.

The quantity to be invoiced is worked out by the supplier, in our case VG. The plots produced by the maxiprint code printers, which can be evaluated by means of EDP (schematic instrumentation A - D), are used as a basis for invoicing. Evaluation itself is carried out by tariff periods; it covers work and power taken. The reactive power consumed is calculated from the meter readings. A charge for reactive power is made only if a defined ceiling is exceeded.

The electricity drawn from VG is measured, transferred to Chemie Linz, and then transformed from the supply voltage (110 kW) to the internal distribution voltage of 6 kW, before being distributed in our works. All relatively large motors (rating more than approx. 150 kW) are supplied at this voltage. In the various supply centers the voltage is tepped down further to 500 or 380 V, to supply small drive units and for lighting purposes.

To make it possible to correlate the electricity consumed with the various users and to keep a check on actual use, all 6 kW motors and all large users and/or production facilities are scanned with suitable instrumentation. A balance sheet of the quantity purchase and of consumption is drawn up once a month, thus ensuring that the measured data are correct.

Now a few words on the electricity tariff:

A special customer pays for his electricity in 2 ways: work charges for active power consumption, and power charges for the power drawn (= basic tariff). As the share of thermal power stations in generating electricity in Austria is highest in winter, the work price to be paid is highest in the months October to March. Prices are lower in the transition months April and September, and lowest of all in the summer months. As a further distinction is made between expensive day (6 AM to 10 PM) and cheap night (10 PM to 6 AM) tariffs, VG actually operate a 6-fold tariff (small consumers pay according to a 2 or 4-fold tariff).

The contribution made by power costs to the price of electricity depends on the number of hours electricity is used for; it is therefore least in the case of steady level users. Power charges are derived from the peak quantity of power drawn from the network (peak consumption during a quarter of an hour).

In the VG tariff 2 peak values during the winter-half year and 2 during the summer-half year are selected to compute a yearly power rating for incoicing purposes. If the power taken is used effectively throughout the year (approx. 7200 h), power charges account for roughly a quarter and work charges for three quarters of total costs.

This makes it clear how important it is to monitor power drawn continuously and to avoid peaks. This is why the supervision center at Chemie Linz AG keeps a permanent check on power drawn and throttles production back if there is a risk of a peak. A load flow monitor device is available to help in this; it displays the permissible consumption level and the actual power being drawn on a screen. If the power drawn (projected on a quarter of an hour) exceeds the setpoint, an alarm is triggered. Any unclaimed amounts of power are also visible on the screen; these can be re-leased for use by the supervision center.

d) Reactive power

Both the VG tariff and the tariffs of the various provincial generating boards provide that charges are payable if defined quantities of reactive power drawn are exceeded.
For instance, the VG tariff permits drawing reactive power free of charge up to 48% (cos phi = 0.9) of active work at the full price tariff, and up to 100% (cos phi = 0.7) at the cut-price tariff. Drawing more than this involved costs amounting to roughly 14% of the active power price in the full price tariff, and around 8% in the cut-price tariff.

It is therefore necessary to stay below the ceilings defined above, in order to avoid charges for drawing reactive power.

In view of the considerable tolerance envisaged, there will hardly be difficulties with this in the cut-price tariff. On the other hand, in the full price tariff a compensation system for reactive current is normally required. Apart from saving money, this type of compensation system also reduces the load on upstream equipment such as cables, load centers, transformers and supply network.
Where electricity-consuming equipment is expanded, one should definitely check - before laying additional cables - whether improved compensation for reactive current might make it possible to save the high costs of cabling.

Control facilities in the steam mains

Shortages in the individual steam mains are made good by feeding in steam from the next level up via suitable pressure reduction stations. This means that any shortage in the overall steam flow is revealed as a defficiency in the 25 bar mains, which must be made good by the steam boiler.

A counterpressure turbine (NO blower on the nitric acid A side, rating 1.1 MW) also reduces pressure from 25 to 7 bar.

If demand for 25 bar steam is low, because the urea plant is shut down or producting at a restricted rate, a further counterpressure turbine for 25/7 bar, coupled to a generator and with a rating of around 0.9 MW, is available.

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Water

To operate equipment and for sanitation Chemie Linz AG need

A) river water
B) well water
C) drinking water
D) boiler feedwater
E) hot water

A) River water supply at Linz works

a) Intake

Capacity: 3 channels, approx. 15000 m3/h unprocessed water each

Energy: approx. 170 to 190 kWh/1000 m3 purified water, i.e. around 6 MW for 30000 m3/h in summer

Other utilities: chlorine gas, pilot air, compressed air, drinking water

Consumption: in winter approx. 22000 m3/h
in summer up to 30000 m3/h (actually the maximum filter capacity)

Water from the Danube river passes through coarse screens, fine screens and a travelling screen to the pumps in the intake facility (building 146).

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Pump data:

2 high-pressure pumps,5000 m3/h each,1100 kW, 61.4 m w.c.,740 rpm

2 high-pressure pumps, 7500 m3/h each, 1450 kW,53.4 m w.c.,740rpm

1 low-pressure pump, 7500 m3/h, 750 kW, 27.0 m w.c., 740 rpm

2 low-pressure pums, 6000 m3/h each, 750 kW, 27.0 mw.c.,740rpm

The high-pressure pumps force the precleaned river water to a total of 18 pressure filters (designed for up to 6 bar), 4 of which are actually twin level filters. After passing through the gravel filter beds (part of which are always in reverse flow, for cleaning purposes), the purified water reaches the users via an extensive network of pipes. The purified water main pressure is approx. 3 bar; it is maintained by the water department (building 107).

The low-pressure pumps supply river water to 12 filters of less modern design (building 107), which are unsuitable for higher pressures. After passing through the gravel filter beds, the purified water reaches 2 unpressurized troughs with capacities of 2280 and 1670 m3, respectively. These buffer the water on its way to the booster pumps, which deliver purified water to the mains.

The network begins with a central pipeline (DN 1400), and then splits up on its way from the east to the most remote users in the north-west of the plant, with the pipe sizes going down accordingly. It may happen that the mains pressure is no longer adequate for remote users, as a result of the pressure drop in the individual lines. To avoid having to raise the overall pressure level, separate booster pumps are installed in such cases.

b) Distribution

As a result of the company's constant expansion, individual sections of the river water mains are already suitable overloaded (flow speeds up to 4 m/sec). Every time it is planned to add a river water user to the system, an investigation must be made of the effect this would have on the pressure situation in the mains. An inhouse computer program works out the mains pressure at every junction and the presure drops in the individual branches. In this way we detect critical points, discuss ways of reinforcing the system, and can input to the computer program, in order to compare the effects and select the most suitable. The program in question can be used to compute pressure drops in piping network for a variety of media (including gases and vapors).

It must be ascertained whether an planned major user (new nitric acid plant) will make it necessary to expand filter capacity!

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c) Consumption

Flowrates at all major users and the input of each individual pump are measured, and a balance sheet drawn up of the differences with the aid of key numbers and predicted data (computer program). At Chemie Linz AG river water is used almost entirely for cooling purposes; after passing through a variety of heat exchangers it is therefore discharged into the drain, heated up around 10 to 20oC on average. The highest consumption rates are compensated for by means of so-called recycling, i.e. coolant water which is only been slightly warmed up, but not contaminated, is pumped back into the network (nitric acid and ammonia plants).

d) Disposal

River water is taken from the Danube river in the intake facility, and returned to the Danube river completely around 250 downstream, by way of the discharge structure (building 147). This facility was necessitated by the construction of the new Abwinden-Asten hydroelectric power station, which raised the level of the Danube river by around 4 m at Chemie Linz AG. As a result, water discharged from our works can no longer simply run off into the Danube river, but must be pumped away.

Capacity: 6 pumps, 10000 m3/h each, 3 to 4 always running, emergency power supply on hand

The Donaukraftwerke AG operate this facility under contract.

e) Power-saving measures

The mechanics of a rotary pump and of the pipeline downstream are such that, for a fixed speed, reducing the pumping rate automatically increases the counterpressure. When turned down, therefore, the pump must overcome a higher pressure than would be needed to overcome pressure drops in the pipeline and static head. At the same time the pump ceases to work at peak efficiency. The unavoidable result is that the power required to drive the pump stays almost constant as the rate of pumping goes down.

Possible countermeasures:

1) Running the pump at full speed with maximum pumping rate the excess water is discharged into the drain. In our special case the Q-H line and the power takeup go down as the rate of pumping increases, while the pressure also goes down. If a drop in pressure is acceptable, running the pump at full speed is recommended as a short-term measure to save electricity without extra investment. At Chemie Linz AG this is being done success-fully with the low-pressure pumps, until a motor drive with speed control is installed.

2) Trimming the pump rotors

This is naturally possible only if reduced output is required; either because the pump was originally too large for the job, or - in Chemie Linz AG' case - because the rise in the level of the Danube due to the power station barrage means that the pressure head to be overcome no longer matches the design data. Reducing the rotor diameter leads to a change in the pump operating data, roughly as follows:

$$Q = Q \frac{D'}{D}$$

$$H = H \frac{D'^2}{D}$$

$$N = N \frac{D'^3}{D}$$

Q, Q' rate of pumping
H, H' pressure head
N, N' power takeup
D, D' rotor diameter

As these equations are exactly true only for rotors with low speeds, it is always worth consulting the pump manufacturer.

3) Motor drives with speed control

Where pumps of the same size are run at different speeds, their pumping data are modified for the aspect of operation in question in line with the following equations:

$$Q' = Q \frac{n'}{n}$$

$$H' = H \frac{n'^2}{n} \qquad n, n' \text{ — speed}$$

$$N' = N \frac{n'^3}{n}$$

i.e. the rate of pummping changes proportionally to, the pumping head with the square of and the shaft power takeup with the third power of the speed ratio.

Looking at the characteristic distribution of a rotary pump, which is yielded by shifting the turn-down curve in parallel, we can recognize that flow control need no longer follow the turn-down curve, but can follow the pipeline characteristic instead. This way the power required for driving the pump can be reduced considerably, particularly where low rates of pumping ar concerned.

At Chemie Linz AG' s Enns works both water pumps were turned down continuously in 1980; this led to the decision to equip one pump with a motor with speed control. As a result, unit electricity consumption was lowered from a mean of 270 kWh to 185 kWh per 1000 m3 water, equivalent to savings of around AS 1.5 M per year.

We then started investigating whether similar savings could be achieved in the intake facility in Linz. It turned out that the various ways of operating pumps in conjunction make the load factor much better than in Enns. Nonethless, calculations indicated that installing one motor with speed control for a high-pressure and a low-pressure pump, and lowering the pressure further, could save approx. 3.9 GWh per year. The new drives will be installed in the course of this year.

4) <u>Optimizing electricity and coolant water consumption in refrigerating equipment</u> as an example of reducing energy costs. Including all laboratory refrigerating devices, around 185 air-conditioning and refrigerating units are in operation at our Linz works, with a total installed refrigerating capacity of approx. 3 MW (approx. 1 MW electrical rating). Owing to increased energy costs, refrigerating equipment should be operated only where actual refrigeration is involved. Air conditioning should be restricted to a considerable extent.

Unit electricity consumption per kW of installed refrigerating capacity increases with increasing condensing temperature; on the other hand unit coolant consumption goes down.

The cost of coolant water is the decisive factor for the overall running costs of a refrigerating unit:
if expensive drinking water is used, the coolant water costs are decisive and the cost of electricity plays only a minor part. Total unit running costs per kW of installed refrigerating capacity go down unmistakably as the condensing temperatur rises. Units of this kind should be operated with the highest possible condensing temperature (minimizing coolant water consumption).

The situation with refrigerating units cooled with well water is exactly the opposite. Here well water, which is comparatively cheap (only extra costs are taken into account), is of minor significance, and electricity costs are the decisive factor.
The graph shows how overall running costs increase with increasing condensing temperature. Units of this type should be run so as to minimize electricity consumption at the expense of coolant water consumption (lowest possible condensing temperature).

From the graph it is also clear that unit overall running cost for units cooled with well water are well below those for units cooled with drinking water. Converting from drinking water to well water saves costs in every case, and should be carried out wherever eco-nomically feasible. (Graph)

B) **Well water supply in Linz works**

A horizontal filter well (building 144) and a vertical filter well at building 88 cover mean consumption of 500 m3/h for the entire works. Owing to its comparative lack of contamination, well water is mainly used for cooling laboratory and air-conditioning equip-ment. The vertical filter well was started up only in 1982; it saves drinking water which we had to use until then.

The well water pumps are also turned down some of the time; however, an in-vestigation we carried out showed that the potential energy savings were not enough to justify capital investment.

C) **The drinking water supply** is provided by the Linz municipal utility company's drinking water mains; consumption in the Linz works is around 1,500,000 m3 per year.

D) **Boiler feedwater**

Most steam system function as closed circuits, i.e. steam is generated and distributed, then condensed in heat exchangers or turbines, and the condensate pumped back to the steam generator. Individual plants monitor the conductivity of the condensate continuously; if it rises above 20 uS, the condensate is discharged into the drain.
Losses are thus continually occuring (contamination in process steam, stripper steam or simply leakages); boiler feedwater must therefore be added to the system continually.

In generating boiler feedwater, the solid and liquid contaminants (dust, oils, petrol, salts) and the gaseous contaminants (oxygen, copper dioxide, sulfur dioxide, nitrogen oxides, chlorine) be re-moved from the water by mechanical and chemical means. Mechanical treatment is done with a KSU ractor and gravel beds, chemical treatment by means of ion exchangers and mixed bed filters. This so-called deionized water is preheated to approx. 98oC with process heat from the ammonia plant; before it enters the boiler feedwater vessels, it is degassed thermally (steam) and chemically (hydrazine), and then pumped to the users.

At the moment 5 lines are available to deionize boiler feedwater: 3 older ones with a capacity of 100 m3/h each, and 2 more recent ones for 150 m3/h each. At full load 3 lines are in operation at any given time (turn and turn about), while the other 2 get regenerated or are on standby.

Boiler feedwater generation and consumption are measured and in-voiced every month.

E) Hot water

Apart from steam, hot water is in increasing use as a heat source. It is mainly used to heat buildings and to warm process water; here and there it is also used for tank and line heating systems. At Chemie Linz AG hot water is heated entirely with process heat, which makes a significant contribution to saving primary energy. Steam gets blown in at intervals only if there is trouble in the system or if outside temperatures are extremely low.
The main source of heat are carbon dioxide vapors, the gas cooling facility in the methanizing stage of the single-train plant, and the gas coolers in the ammonia plant in building 305. Waste heat from compressors is also used on occasion.

Capacity: in winter approx. 700 m3/h of circuit water are heated from around 80 to 92oC in the single-train plant, and then pumped to the various users via 3 heating circuits. The coolant water re-turning is fed back into the loop, closing the circuit.

heating circuit I:	200 m3/h, supplies more or less the center of the works
heating circuit II:	400 m3/h, supplies the southern section
heating circuit III:	100 m3/h, supplies the northern section

The water flowrates and temperatures in the heating circuits are measured, as is the consumption of the main users. Subsidiary users get charged for estimated consumption on the basis of outside temperature. Invoicing is carried out per month.

Our department is continually carrying out investigations to find out how far buildings that are currently heated with steam can be connected up to the hot water circuits at reasonable expense.

<u>The technical gases</u>

At Chemie Linz AG compressed air, pilot air, nitrogen, oxygen and mixed gas are generated as technical gases, treated and supplied to the users.

A) Compressed air

Mains pressures: 3 to 4 bar, and 6 bar

Generators: Demag Turbo, building 204, approx. 7000 m3/h at 4 bar Aerzener screw-type compressor, building 44, approx.
7000 m3/h at 4 bar

Users: all plants (approx. 14000 m3/h) except for APP/APZ sector (compound fertilizer production), which has its own supply of compressed air

Back-up facilities: Borsig compressor, building 204, approx. 1 200 m3/h at 6 bar
Atlas Copco, building 6, approx. 960 m3/h at 6 bar
excess pilot air, building 401

3 IPEC compressors, building 424, 1200 m3/h at 2.8 bar each - normally used directly for mill building 403 if required

If necessary, all compressors in the APP/APZ sector (building 601) can be used to supply the mains. The Sulzer compressor in building 530, capacity approx. 3500 m3/h, supplies the C sector; any excess is dried and fed into the pilot air mains.

B) Pilot air

Pilot air must be dried to avoid condensate or ice forming in/on sensitive instruments. Two air drying plants are in operation in our works; both use silica gel adsorbers, regenerated with steam-heated air.

At the moment our works consume up to 3800 m3/h of pilot air, normally supplied by the following equipment:

Atlas Copco screw-type compressor,	building 401, 1600 to 1 800 m3/h
Sulzer compressor,	building 530, 1000 to 1 200 m3/h
pressure vaporizer,	building 214, 400 m3/h
single-train plant,	building 215, 600 m3/h (of which 470 m3/h for own use)

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Of the 2500 m3/h which the Atlas Copco screw-type compressor in building 401 delivers, an excess 700 to 900 m3/h are available for the 6 bar compressed air mains.

Production rates for both compressed air and pilot air are measured, as are larger consumers' consumption rates. Smaller users are charged on the basis of estimates. Invoicing is done once a month.

C) Nitrogen and oxygen

A central air separation plant using the Linde-Fränkl process is installed in building 204 to separate atmospheric air into nitrogen and oxygen.
A gas can be liquefied only below the "critical temperature". In the case of air, the critical temperature is around -140oC. Air compressed to anything up to 180 bar is cooled in intermediate coolers acted on by river water, and then cooled further in a countercurrent system by the cold gases coming from the distillation equipment. Beyond, the already highly cooled air is reduced in prssure by means of a throttle valve, producing liquid air (Joule-Thomson effect).
The air can now be separated into its components by fractional distillation. Nitrogen, which has a lower boiling point (-196oC), evaporates first, while the oxygen (boiling point -183oC) content of the residue increases steadily.

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Facilities: 2 Fränkl systems with a capacity of approx. 1750 m3/h pure nitrogen and up to approx. 2000 m3/h purging nitrogen (at most 2% oxygen, mean value 0.4% oxygen) each.
Excess purging nitrogen and other components already used as cooling media are vented into the open.

The oxygen is used for cracking methane in the gas plant, and any surplus quantities are used to increase production in the nitric acid plant.
Nitrogen is used mainly for purging and shrouding. Invoicing is done once a month, as for air.

There no back-up facilites for the Fränkl systems (installed around 1940). If a system breaks down or need repairing the rate of ammonia and/or nitric acid production must be reduced (optimi-zing sales).

D) Mixed gas

A number of gases with varying calorific values accumulate from the pressure reduction stages of ammonia station, and mixed with natural gas as required to a mean calorific value of 1.85 kWh/m3 (1600 kcal/m3).

The individual components of the mixed gas are:

- gas from turbine pressure relief (TEG) from the carbon dioxide scrubber, mean flowrate 4000 m3/h, calorific value 1.7 kWh/m3

- gas from synthesis pressure relief and recycling pressure relief (SEG/REG) from the ammonia synthesis process and the intermediate pressure relief equipment; most of this gas mixture is supplied to the argon plant, while the excess goes to the mixed gas station -mean flowrate 200 m3/h, calorific value: SEG
  4.7 kWh/m3, REG 3.6 kWh/m3

- natural gas (EG) is fed in by a TEG/EG ratio control device, to keep the calorific value of the mixed gas more or less constant;
  mean flowrate 590 m3/h, calorific value 10 kWh/m3.

This mixed gas supplies the mixed gas demand in our works: around 95000 MWh per year. The users are: the lime mills (building 403), the gypsum drying facility (building 424), and the ammonium sulfate drying facility (building 424).
Accounts are made up and invoicing is down once a month for mixed gas production and consumption; this also applies to checking the calorific values.

E) Steam

The production steam needed for most of Chemie Linz AG's products is produced mainly by utilizing process heat to generate steam. In the winter months, with space and ancillary heating systems in use and increased demand for products making in which steam is consumed, demand for steam is high, so a steam boiler must be opoerated from November to March; by contrast, a surplus of steam of more or less the same exists in the summer months.

Since the various sources of waste heat used to generate steam do not have anything like a consistent temperature level, the steam pressure at the various producers differs considerably. Transporting the steam generated therefore involves several steam pipe networks, with a total length of around 18 km.

Chemie Linz AG possesses pipe networks for the pressure levels:

1. 25 bar

producers:	nitric acid jplant	approx. 44 t/h
	Wamser boiler	up to 65 t/h from natural gas
consumers:	urea plant	at most 44 t/h
	ammonium nitrate plant	1.5 t/h
	concentrated nitric acid plant	2.5 t/h

2. 20 bar

producers:	single-train plant	5 to 17 t/h
	boiler house (bldg.110)	2 x 10 = 20 t/h from oil or natural gas
	supply from VOEST-Alpine	up to 25 t/h.pa
consumers:	melamine plant	8 to 14 t/h
	fibres and no-woven	0.8 t/h
	pressure gasification (only if faults develop)	17 t/h
	heating in buildings	1 to 6 t/h
	VOEST-Alpine Linz	5 to 18 t/h

3. 7 bar

producers:	pressure gasification:	
	1.1 t steam/t N	19 to 22 t/h
	sulfuric acid from crude sulfur: 1.1 t steam/t H_2SO_4	9 t/h
	MSA	5 t/h
	phthalic acid anhydride production	4 t/h
	nitric acid plant	27 t/h
consumers:	ammonium nitrate plant	15 t/h
	urea production	3 to 10 t/h
	ammonium sulfate	3 t/h
	pharmaceutical product.	4 to 6 t/h
	pesticide production	4 to 7 t/h
	phthalic acid ester plasticizers	3 t/h
	fibres and non-wovens	3 t/h
	heating, other users	5 to 15 t/h

4. 3.5 bar

producers:	urea plant	0 to 3 t/h
consumers:	melamine plant	0.5 to 3 t/h

5. 2 bar

producers:	pressure gasification: 0.4 t steam/t N	4 to 7 t/h
	ammonia plant: 0.6 t steam/t N	14 to 22 t/h
consumers:	melamine plant: 3 t steam/t	6 to 12 t/h
	ammonium sulfate production	6 t/h
	boiler feedwater production	3 to 8 t/h
	gas plant: 0.5 t steam/t N	3 to 7 t/h
	nitric acid plant	1.5 t/h
	pesticide production	3 t/h
	heating in buildings, other users	5 to 10 t/h

Metering

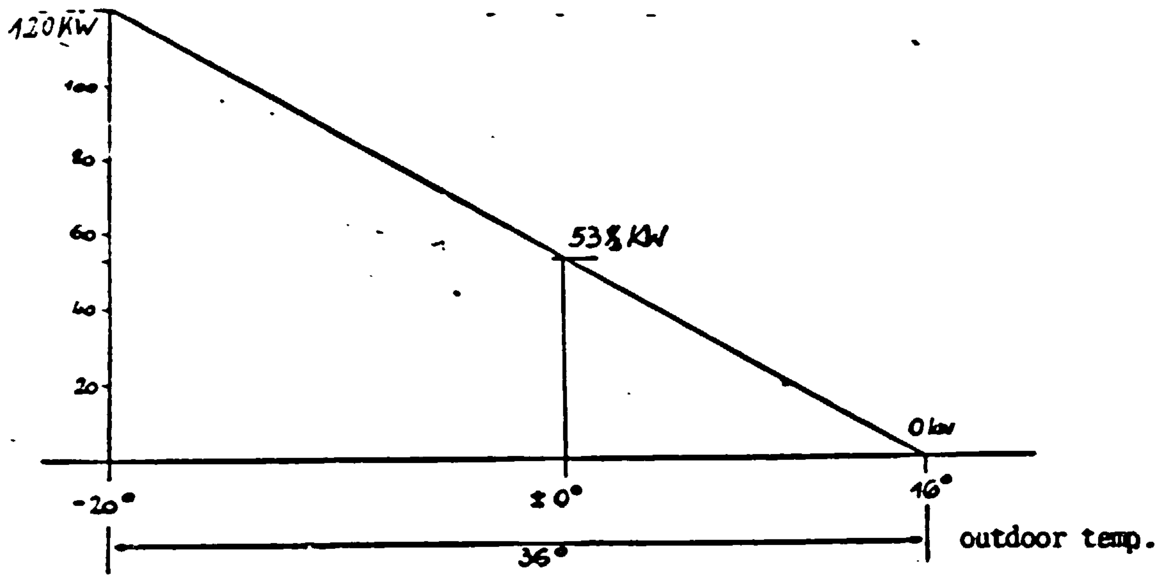
Steam flowrates - both at all producers and at most consumers - are measured by means of orifices, with corrections made for pres-sure and temperature.

The measurements are evaluated every day, and the results stored in a data bank. The steam consumption for all space and back-up heating systems (if not already measured) is worked out by means of a summing graph as a function of the outside temeprature each day.

Constructing a summing graph on the basis of installed heating ca-pacity

Before a heating system is installed in a building, the heat out-put required is calculated exactly, taking insulation, location, window size etc. into account, and the heating scaled accordingly. Hot steam consumption can then be calculated from installed heating capacity and the outside temperature.

E.g.: installed heating capacity 120 kW for -20oC



increase in demand per oC = $\frac{120\ KW}{36}$ = 3 1/3 kW/oC

heat required at 0oC = 3 1/3 x 16 = 53 1/3 kW

demand formula: (53 1/3 kW - 3 1/3 kW x outside temperature 16) x 24 h = kWh per day

If the heat required by several buildings is to be calculated, the individual values can be added together, e.g.:

summing formula: (133.33 kW - 8.58 kW x outside temperature 16) x 24 h = total kWh per day

Days multiplied by measured and computed steam consumption account for around 97% of total steam consumption; leaks from pipes and other quantities of steam worked out only once a month account for the remainder.

As the quantities of steam measured are compared with the corresponding production volumes and/or quantities of raw material is used, mistakes in invoicing for steam can be dealt with immediately - and wateful methods of operation identified without delay.

Increased steam wastage, e.g. leaks from valves, excessively low setpoint setting at blow-down devices, are revealed by comparing consumption and generation.

Apart from the steam pressure levels and networks described above, steam systems with pressures of 135, 115, 40 and 38 bar are also in internal use to drive turbines and as process steam.

This volume of steam, which is of the same order as that consumed in the various steam mains networks, is also measured on the generation and consumption side; however, the resulting data are used not so much to track down steam wastage as to optimize operating procedures, i.e. improve the thermal efficiency of the plant.

Making use of surplus steam

In the summer months a surplus of steam up to around 10 t/h currently occurs. The question of how to make the best use of this steam is continually being discussed with the production teams in questions and with the marketing department, and suitable projects drawn up.

At Chemie Linz AG the following ways of utilizing steam exist or are planned:

- Electricity generation in condensing turbines, e.g. 7 to 17 t/h (approx. 5 mW) in the single-train plant, and 4 to 6 MW (depending on procedure) in Enns (condensing turbine with moving tapping)

- Production scheduling, i.e. allocating the bulk of production involving heavy steam consumption to the summer months, to the extent that storage capacity and marketing situation permit this (e.g. melamine)

It is also worth considering throttling back production activities which generate steam (e.g. nitric acid, sulfuric acid).

- Installing steam-heated air preheaters to dry products and thus primary energy (e.g. NPK fertilizer and lime/ammonium nitrate plants)

- Supplying waste heat to district heating facilities and suitable industrial plant users who need steam for their production

A facility also exists for supplying steam to/taking steam from VOEST-Alpine via connecting line. Chemie Linz AG is entitled to take small amounts (1 to 4 t/h) of steam needed at short notice - beneath the minimum load level for the boiler - or alternatively supply excess steam (4 to 10 t/h at 20 bar) to VOEST-Alpine Linz. As the steam taken from outside costs considerably more than the steam delivered outside (only evaluated for generating electricity), the supervision center monitors the shared metering facility, so as to take appropriate action if steam is taken from outside over a long period.

- Starting up a boiler feedwater turbine (building 214) to save pump electricity. The steam fed in is reduced in pressure from 7 bar to atmospheric pressure.

<u>Here we provide a brief survey of ways in which waste heat is used at Chemie Linz AG:</u>

- Waste heat boiler in the pressure gasification facility: 2 bar, 7 t/h, using the contact heat

- Waste heat boiler at Enns: 42 bar, 26 t/h to generate electricity, using the flue gases from an incinerator

- Adding a downstream heating surface to improve the efficiency of an oil-fired steam boiler at Leifa in Neumarkt: 12 bar, 2 t/h - or new boiler (planned)

- Using the condensation heat of a column head product to heat up a vacuum column (acrylonitrile plant in Enns: approx. 6 t/h of steam can be saved: planned)

- Process modifications (urea plant, single-train plant, pressure swing adsorption: planned)

- Various air preheaters: with surplus steam (NPK fertilizer, lime/ammonium nitrate: planned with flue gas (melamine, acrylonitrile: planned)

- preheating condensate and boiler feedwater

The possibility of using heat pumps or ORC systems must be checked from case to case to see whether it makes economic sense in the light of the existing price situation.
In all case it is vital to carry out a systematic search for suitable sources of waste heat!

Reducing heat dissipation by providing more insulation

At a cautious estimate, the Chemie Linz steam networks dissipate radiant heat to the tune of AS 5 to 8 M per year, at a steam price of around AS 200,--/t. Since the insulation thickness have not changed over the last 15 years (works standard), US-ES mooted the idea of responding to greatly increased energy costs by providing thicker insulation to the extent that this makes economic sense.

An investigation revealed that increasing the insulation-thickness by 30 to 50% on average, in order to reduce energy losses, is a paying proposition. As a result, the relevant standard was revised accordingly.

Statistical checking method to monitor energy consumption

Statistical methods can be used evaluate the effects of any given measure taken (e.g. starting up a facility to utilize waste heat). In such cases graphical methods are very suitable, as they reveal the essential elements in a form easily appreciated, and are easier to grasp than extensive table of data.

As an example, we present a comparison between unit enrgy consumption in our Enns works (propylene, natural gas, electricity) and unit propylene consumption. While unit propylene consumption has been steadily reduced by means of process improvements, starting up the waste heat system produced a significantly greater production in unit energy consumption (intersection of the 2 plots).

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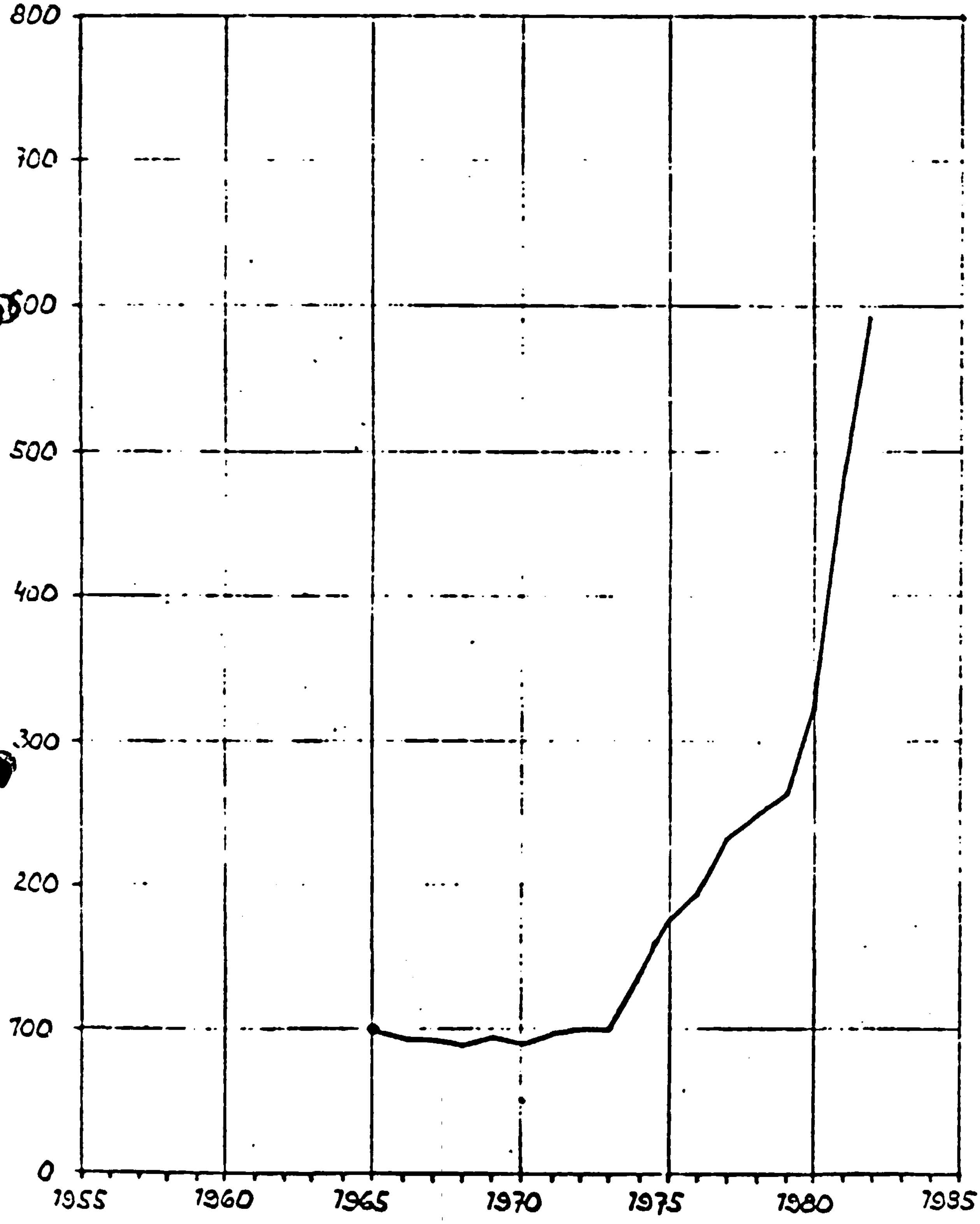
NATURAL GAS PRICE TREND

1965 = 100

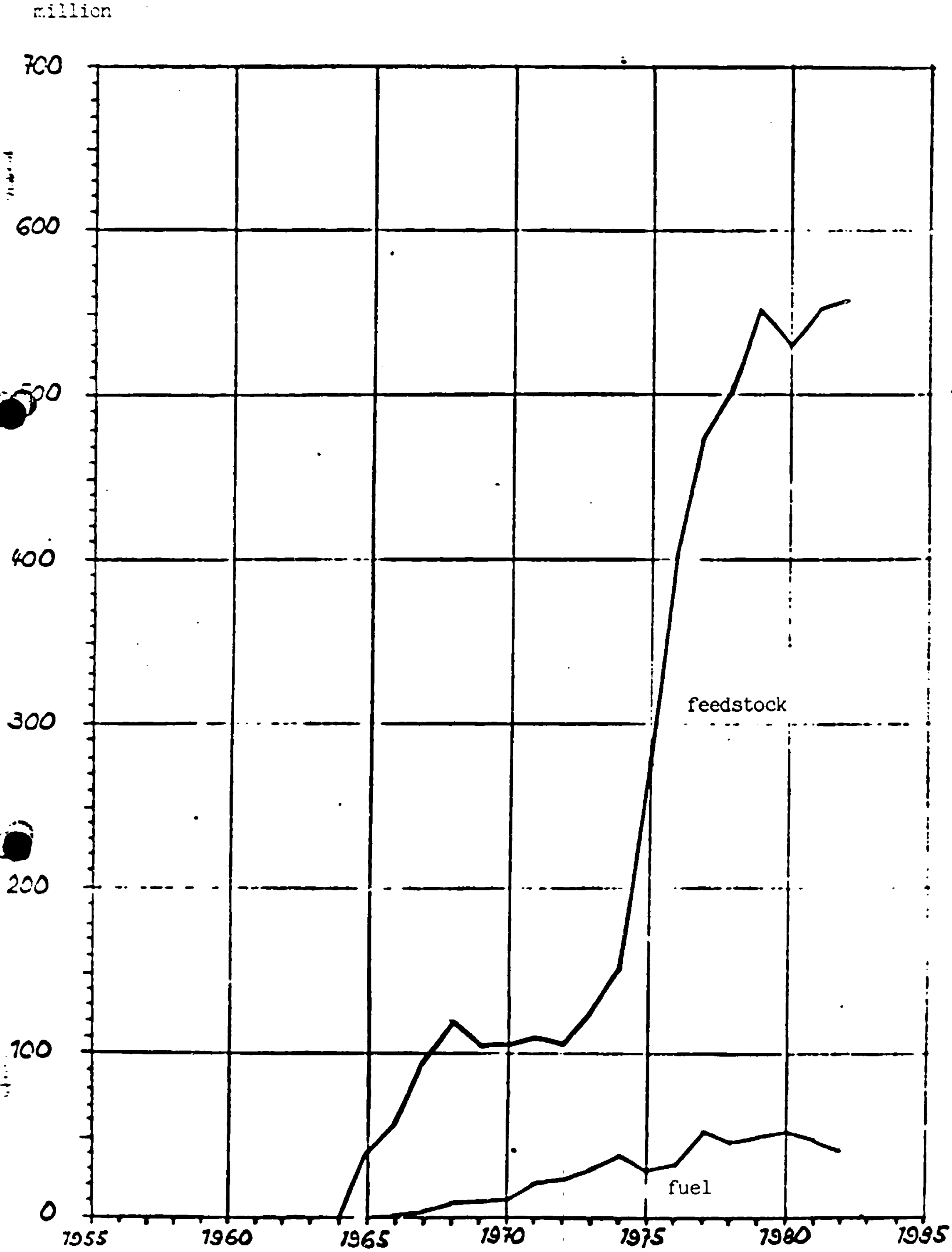


UU St.

CHEMIE LINZ AG

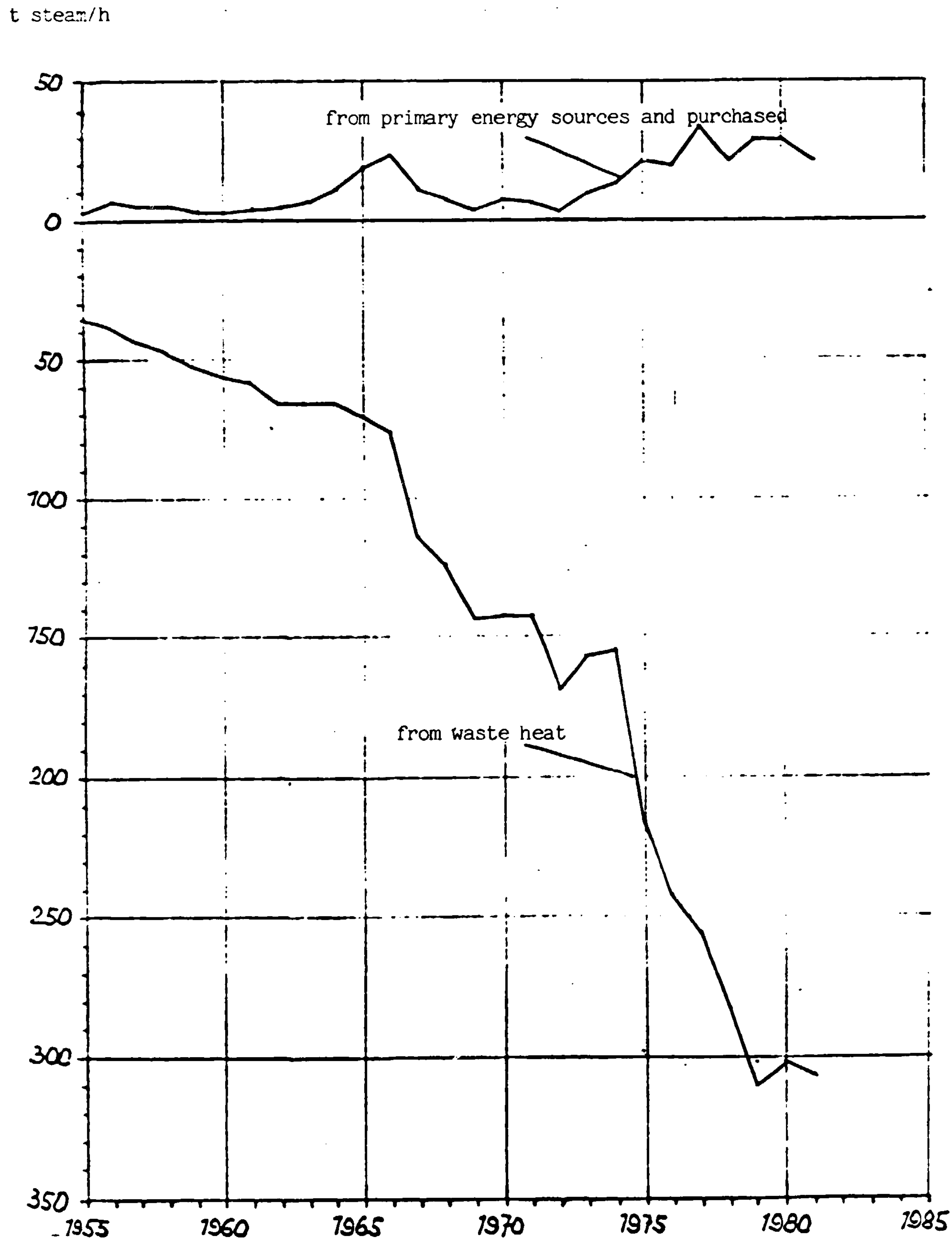
NATURAL GAS CONSUMPTION

(including Enns)



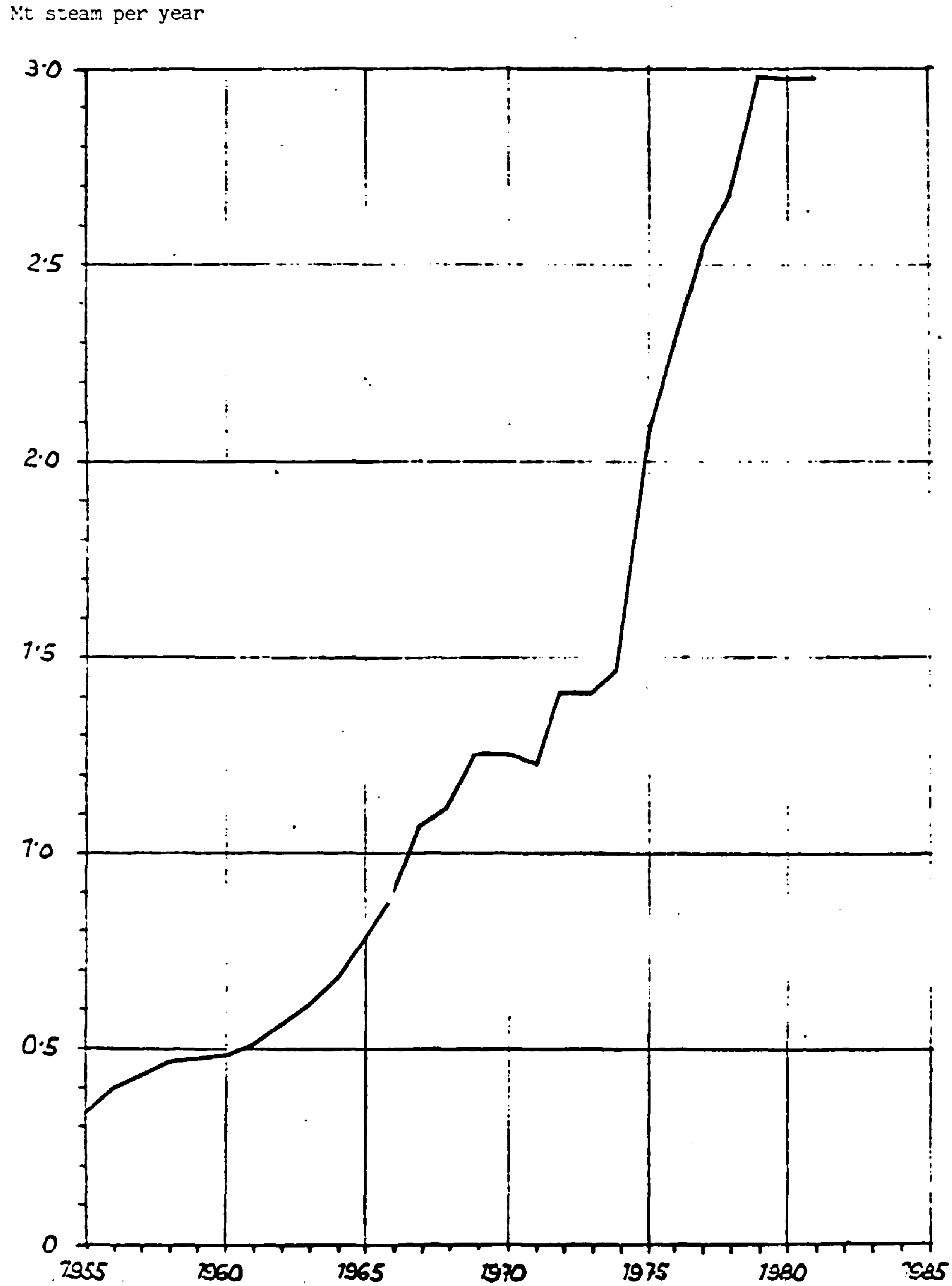
UU-St.

STEAM GENERATION IN LINZ PLANT



uu. Gr.

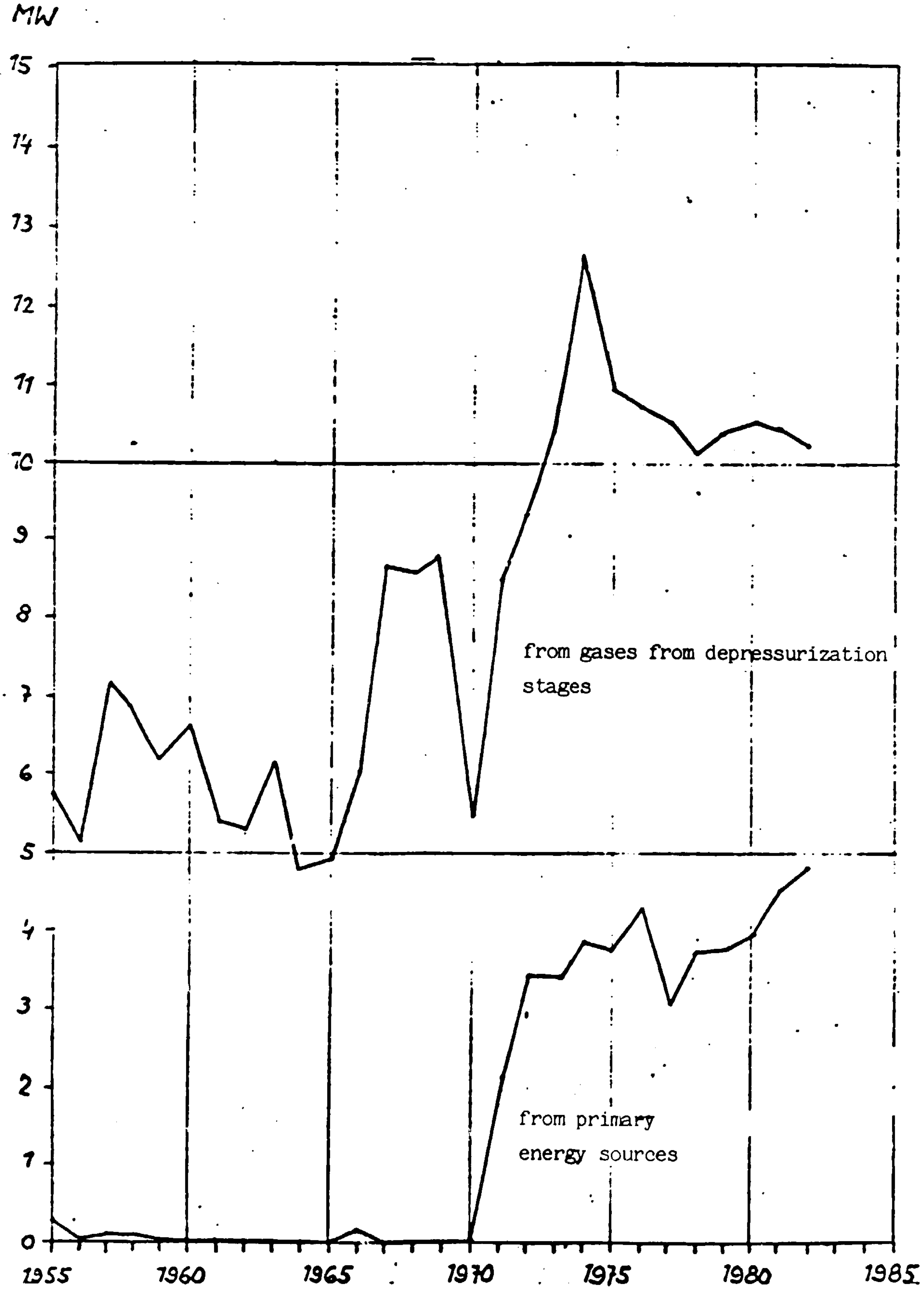
STEAM CONSUMPTION IN LINZ PLANT



uu. 87.

CHEMIE LINZ AG

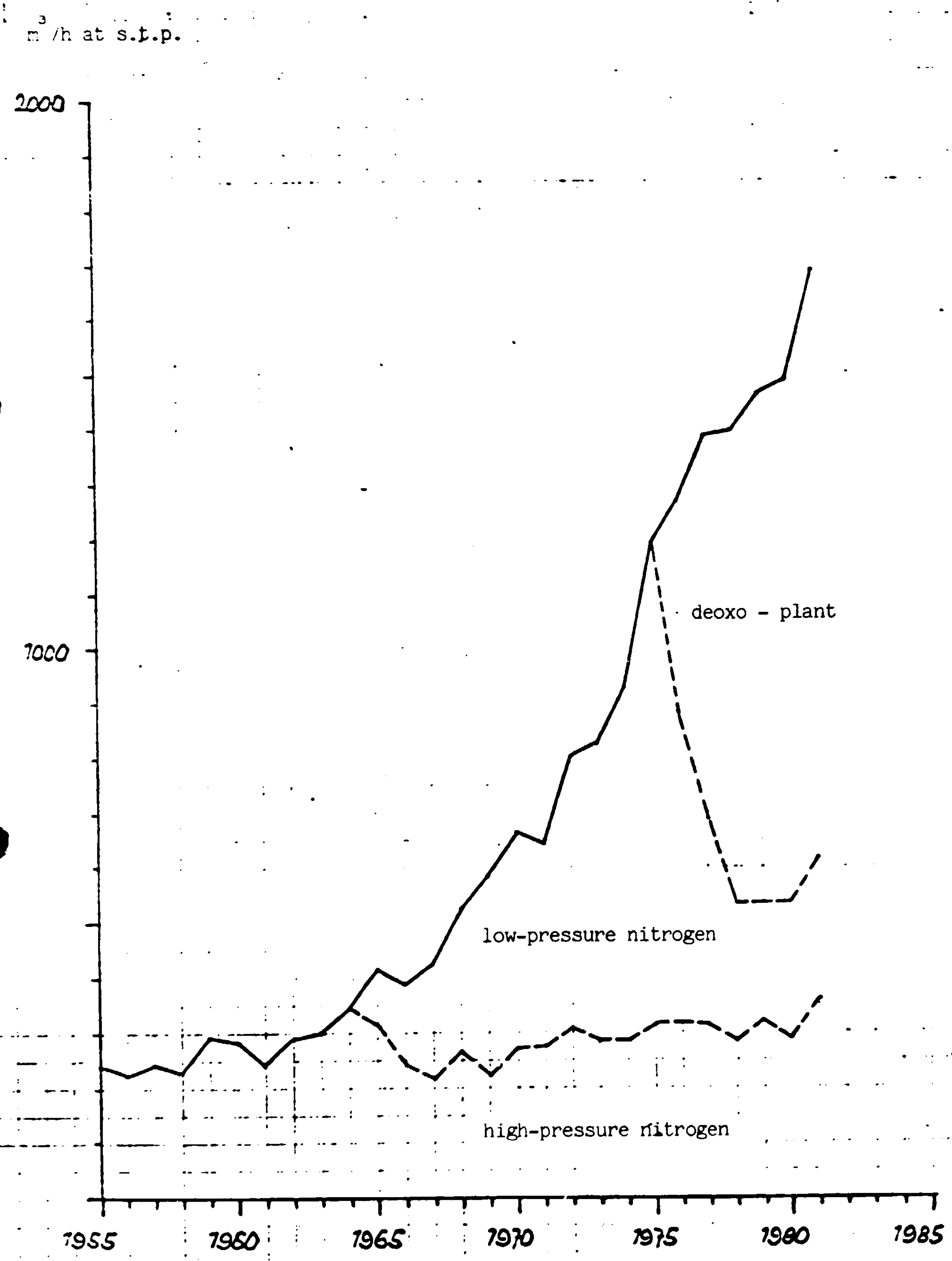
MIXED GAS



UU-St.

PURGE NITROGEN CONSUMPTION

IN LINZ PLANT



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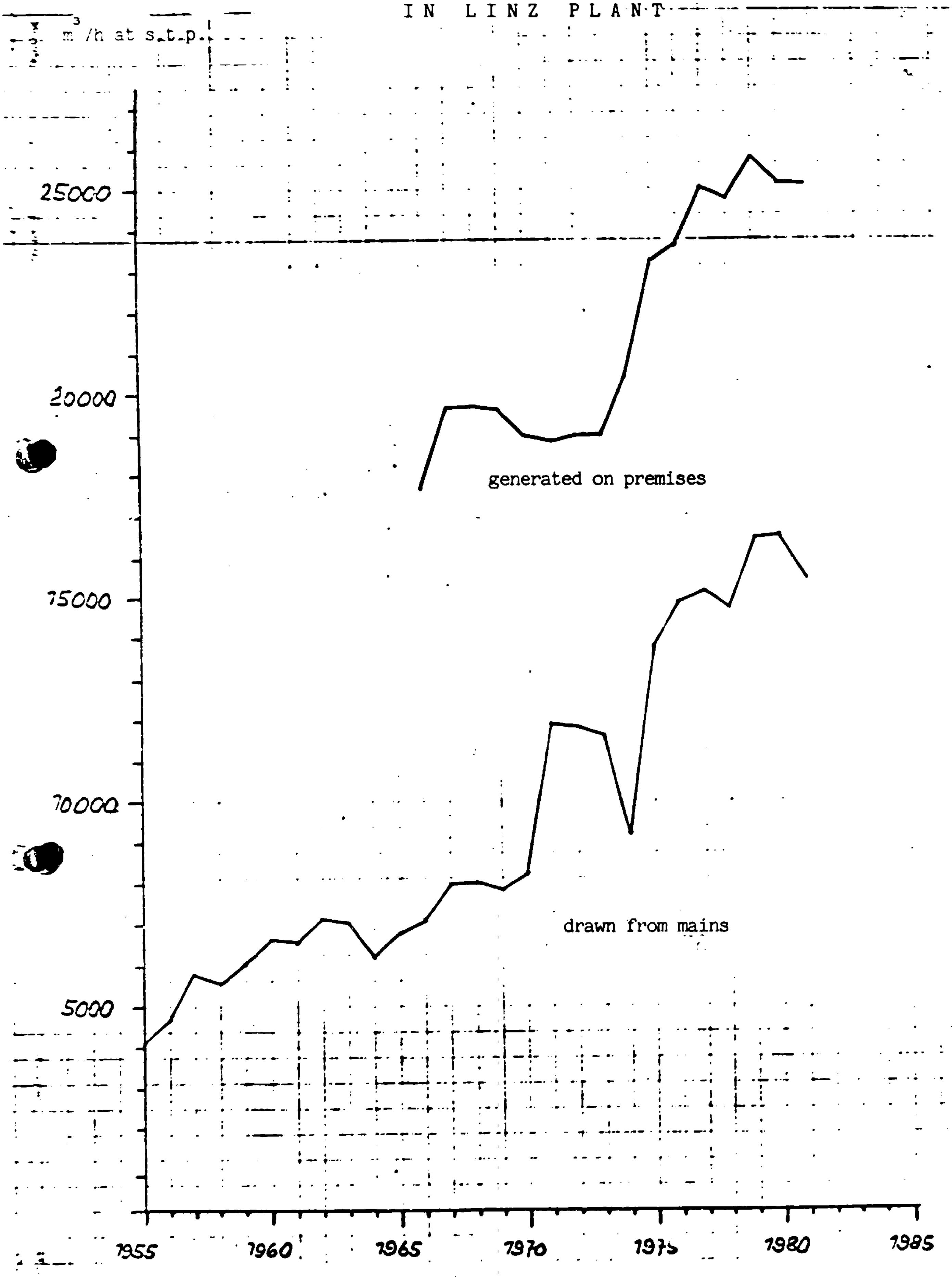
COMPRESSED AIR CONSUMPTION

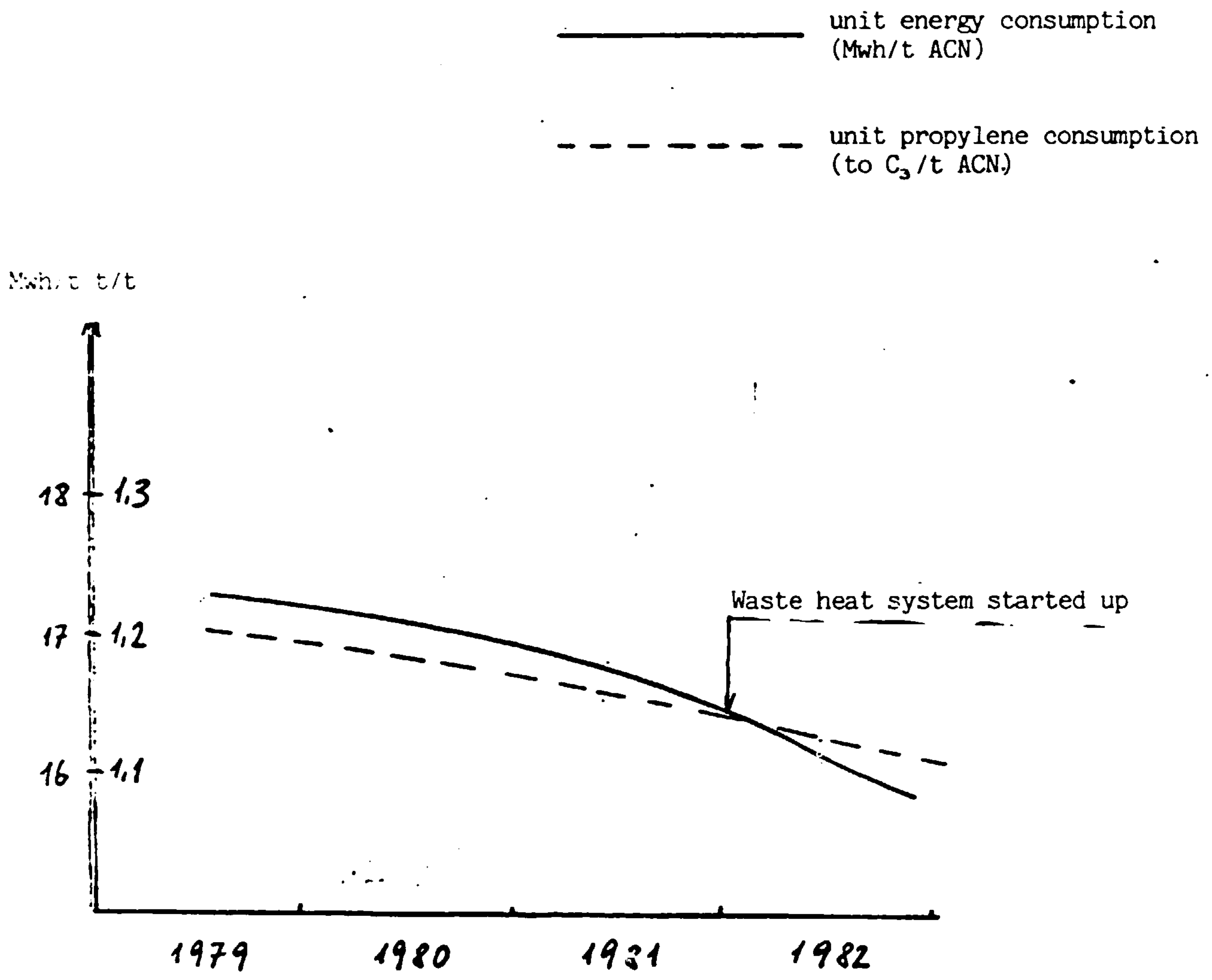
IN LINZ PLANT

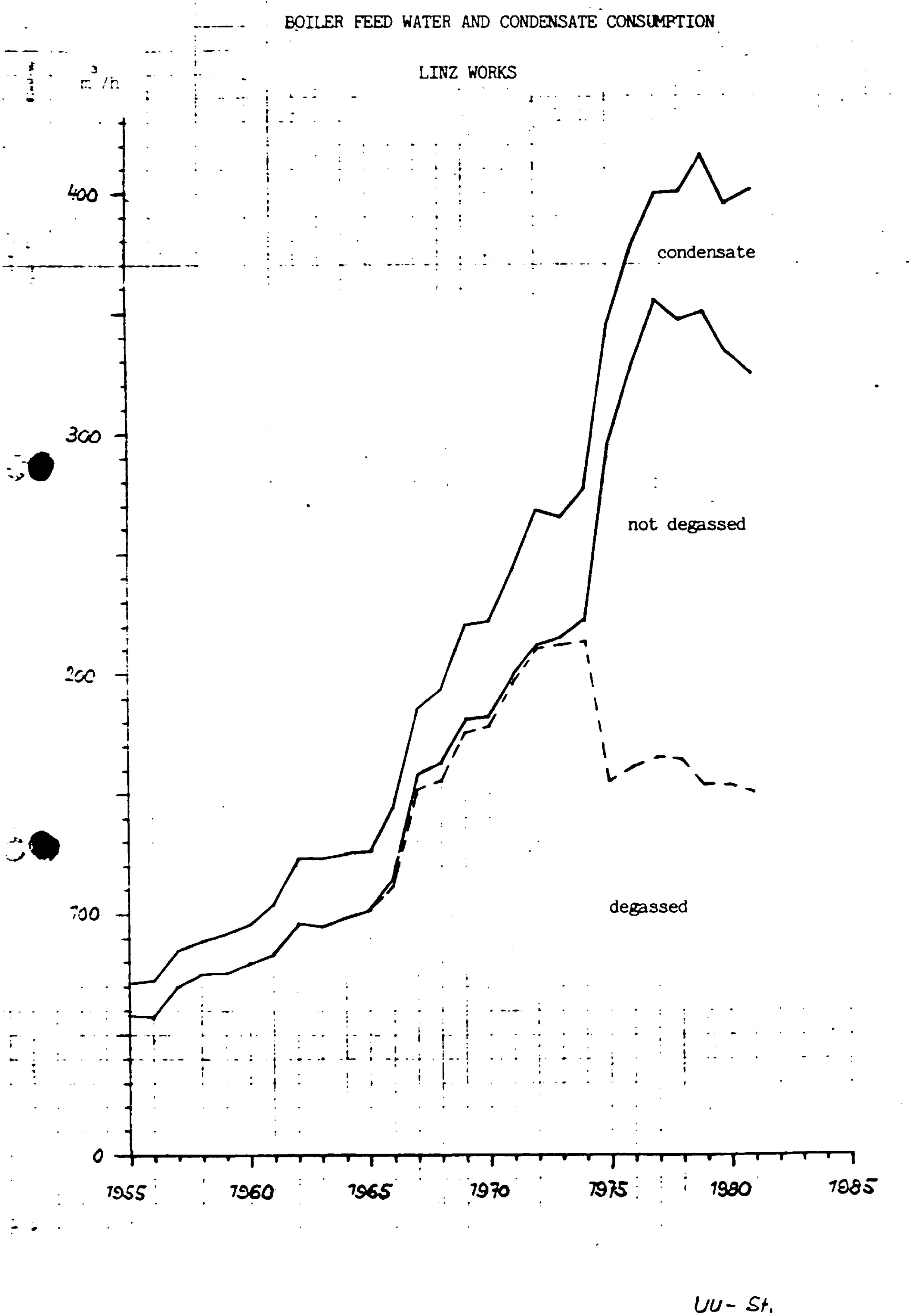


UU. St.

MEAN UNIT ENERGY CONSUMPTION AND PROPYLENE CONSUMPTION

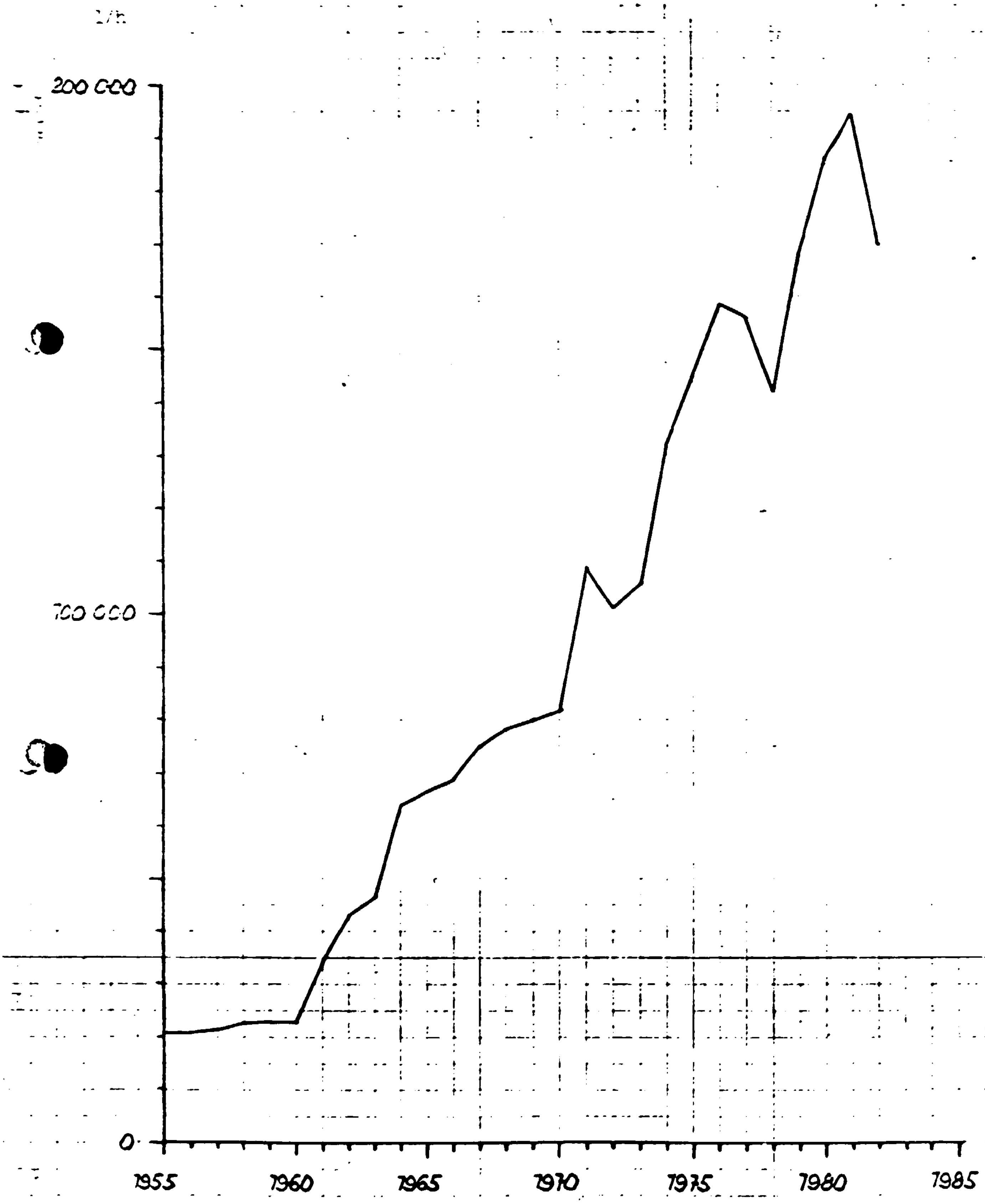
IN ENNS PLANT



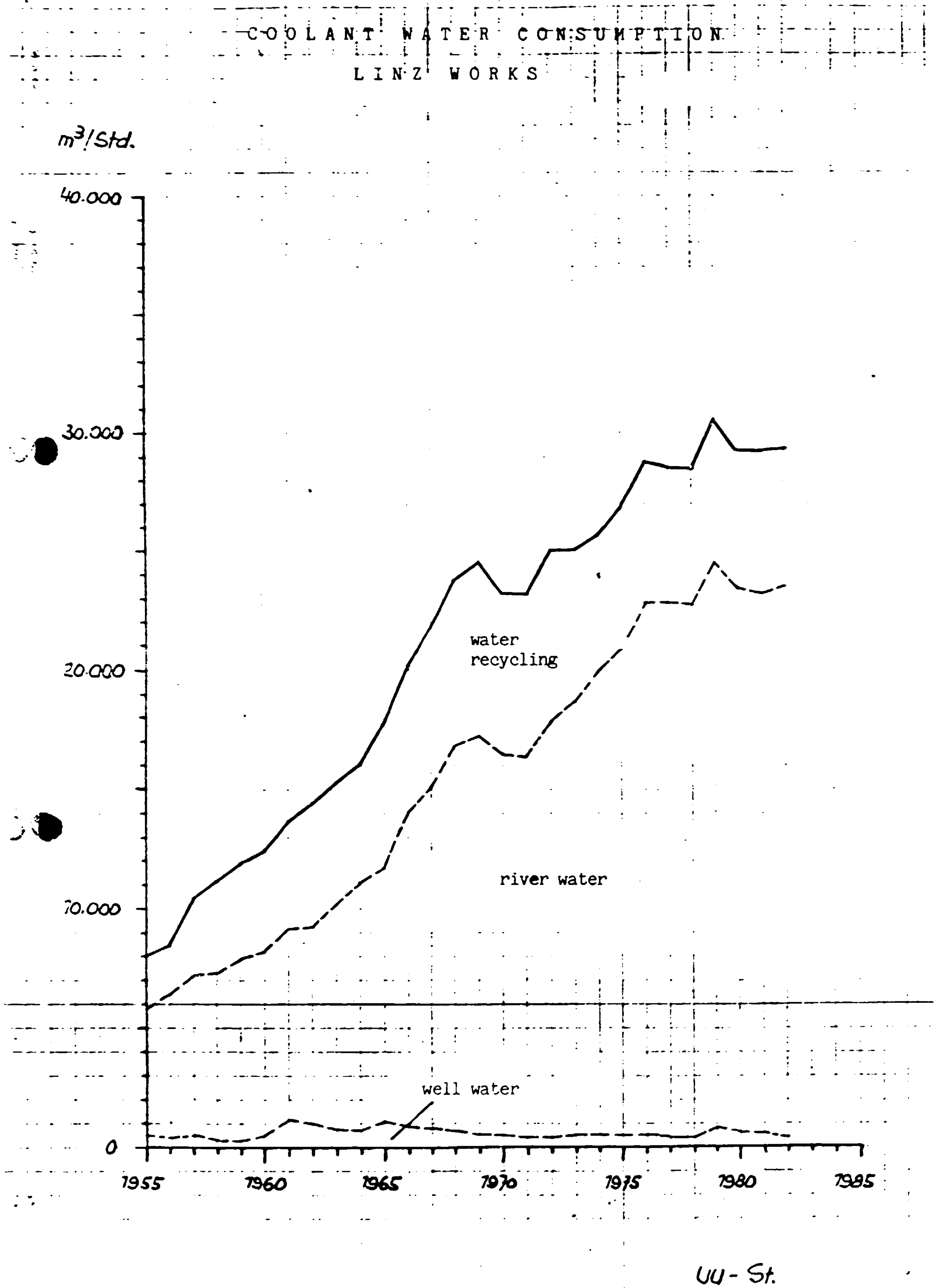

BOILER FEED WATER AND CONDENSATE CONSUMPTION
LINZ WORKS
m³/h
400
300
200
100
0
condensate
not degassed
degassed
1955
1960
1965
1970
1975
1980
1985
UU- St.

DRINKING WATER CONSUMPTION

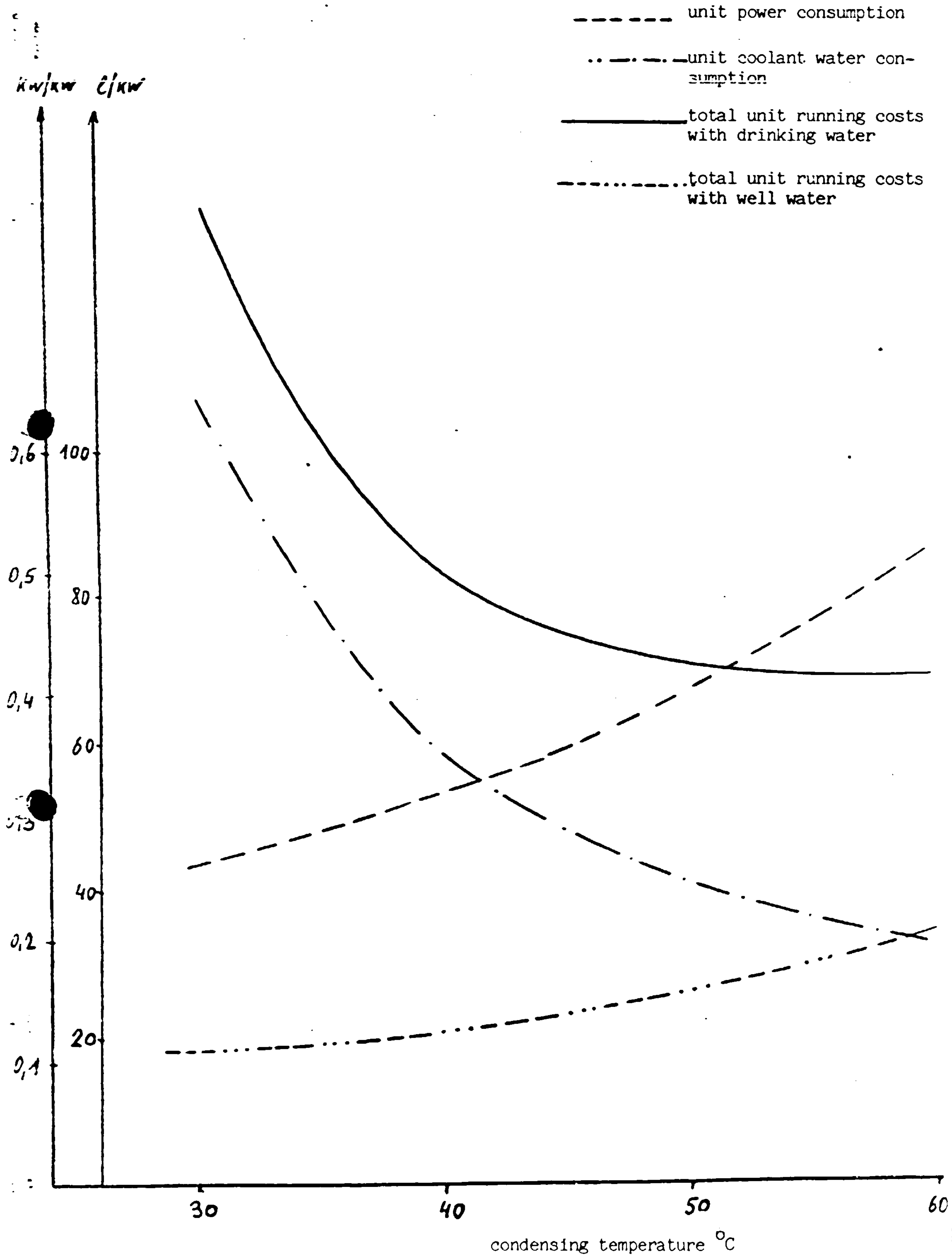
LINZ WORKS



UU-St.



COOLANT WATER CONSUMPTION
LINZ WORKS
m³/Std.
40.000
30.000
20.000
10.000
0
water
recycling
river water
well water
1955
1960
1965
1970
1975
1980
1985
UU-St.



unit power consumption
unit coolant water consumption
total unit running costs with drinking water
total unit running costs with well water
kW/kW
¢/kW
0,6
0,5
0,4
0,3
0,2
0,1
100
80
60
40
20
30
40
50
60
condensing temperature °C

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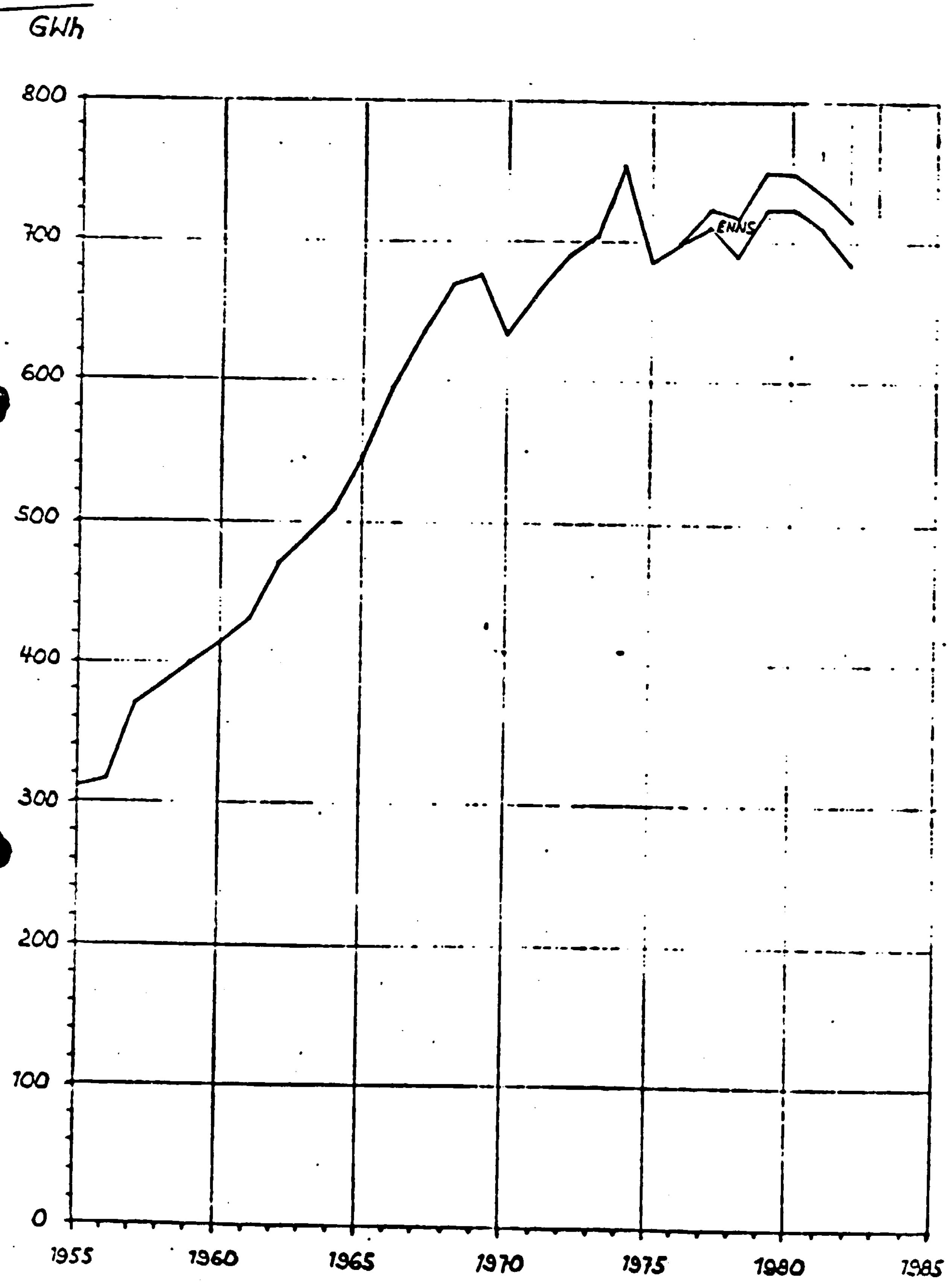
POWER CONSUMPTION

(including Enns)



UU-St.

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6. U N I D O - W O R K S H O P

ON FERTILIZER PLANT MAINTENANCE

19. September - 4. November 1983

13482
(2 of 2)

D O C U M E N T A T I O N - PART II

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CO2 liquefaction plant

This CO_2 liquefaction plant with a capacity of 5 t/h is situated in building 219.
There are two lines for 2.5 t/h each. The area occupied is 1500 m2, including space for a third line. The plant belongs to Fa. Klara; Chemie Linz is responsible for running it.

The start up of the plant was in 1982, the erection time 2 years.
The cost of this plant was 70 million S.

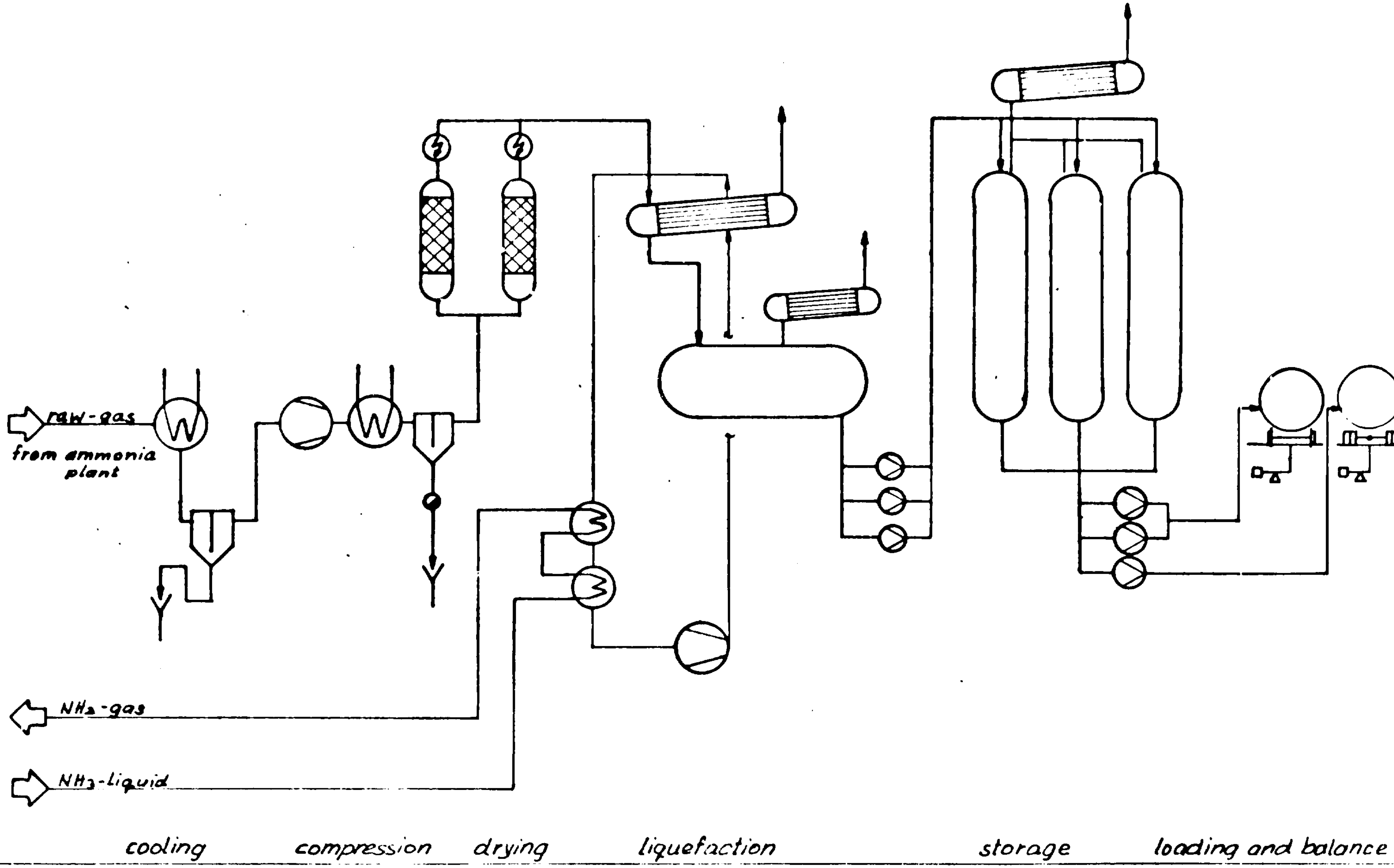
<u>Process</u> see process flow sheet

CO_2 saturated with H_2O vapor from the Benfield system of the ammonia plant at 85oC and 1.1 bar is cooled to 30oC. A compressor condenses the gas to 15 bar. In the molecular sieves beyond the gas is dried (dew point -70oC).
The liquefaction is carried out with an ammonia refrigeration circuit. The cold HN3 gas (-38oC) is compressed by a screw-compressor and then reliquefied. Components such as nitrogen and hydrogen which stay gaseous in the CO_2 condenser, are removed by expansion. So purity is very high (99.99%). This is the quality you need for using in the food industry. Now the liquid CO_2 runs down in a vessel with a capacity of 75m3.

Pumps transfer the pure cabon dioxide to 3 storage vessels. Each vessel has a capacity of 250 t. The carbon dioxide is stored at -35oC and 15 bar. CO_2 is loaded in road or rail tankers as required.

In case of having hard orders for using CO_2 in provisions (food industries) we must be very careful by loading and we must make many analysis.

The stringent requirements of food processing make clean, conscientious working essential, particularly as regards loading in tankers, and also necessitate an expensive and complicated analytical program to ensure product purity.



C… LINZ AG

…echtagesetz vom 9. 4. 36 stehen uns zu

Maßst

CO_2-Liquefaction
Building No 219

gez. 1MB0720 Hrc

ARGON PLANT

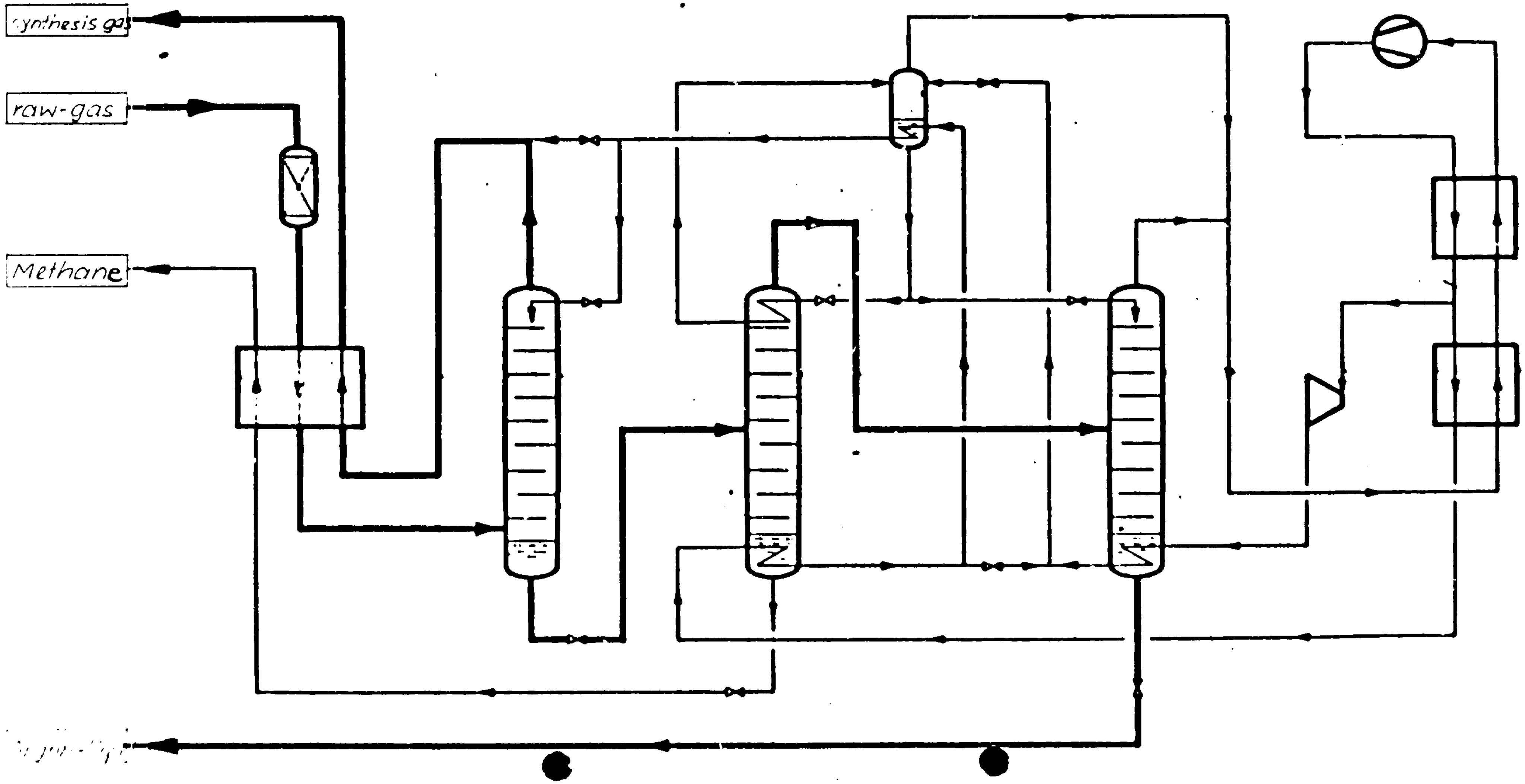
Planning, design and erection of the argon plant took 18 months. The operating area is about 600m2. The total cost were about AS 80 M. This plant belongs to Linde, Industrial Gases, Austria, and is operated by Chemie Linz AG under contract.
A plant to extract argon from depressurized synthesizer gas has the advantage over air separation plants that the equipment operates non-stop, so that argon is continuously extracted on a defined scale, whereas argon production is a function of oxygen production in the case of the air separation process.
Argon is used as an inert gas for argon arc welding, for annealing metals, for manufacturing of electronic components and as a purge gas for cleaning molten metal.

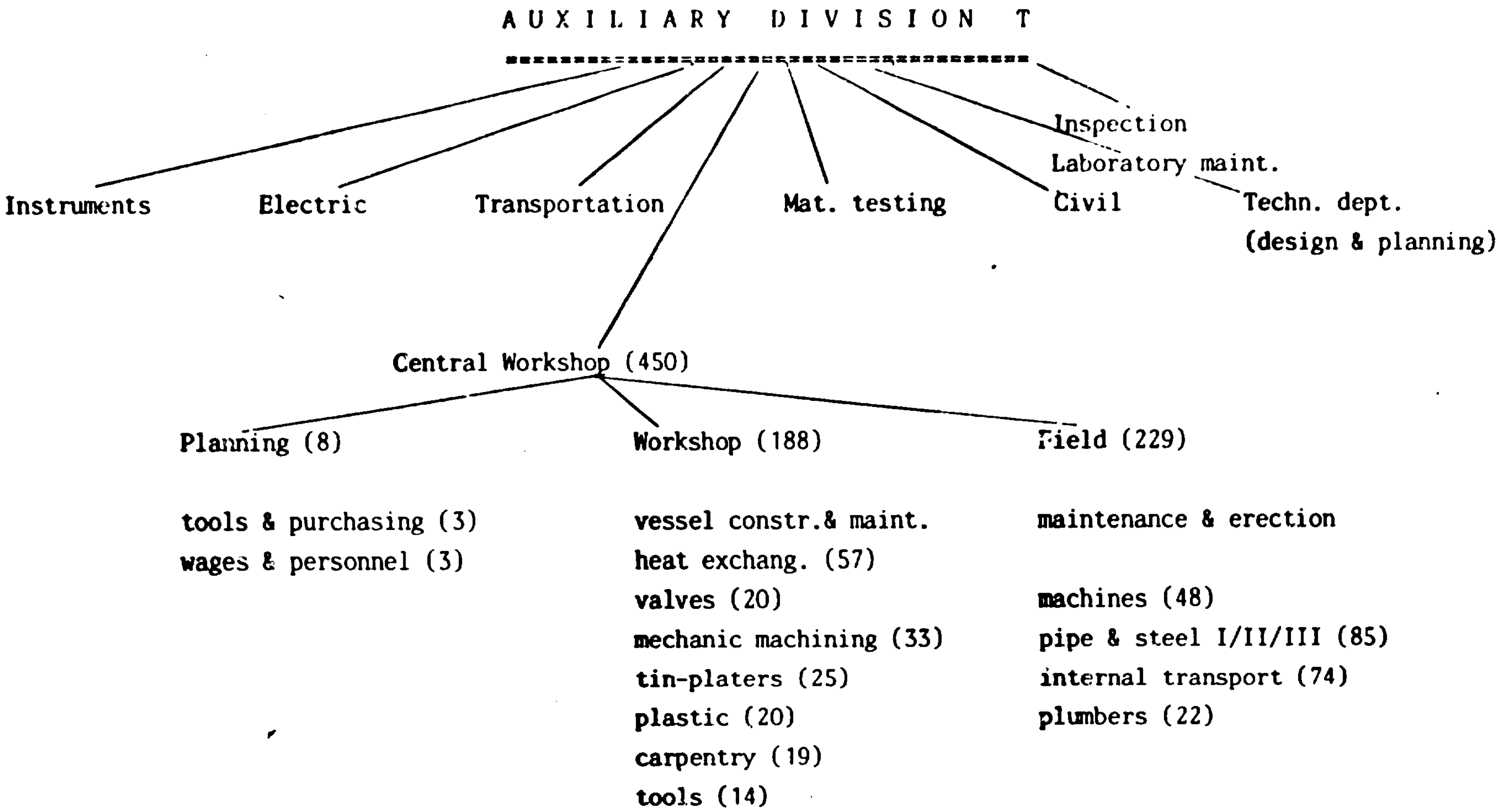
The plant produces 6900 tonnes of argon per year from the waste gas from the ammonia synthesizer which is used to be burned. The components of this waste gas argon, nitrogen, methane and hydrogen. The gas is processed in a low-temperature process in which temperatures of -190oC are obtained. So before the gas is cooled down it is dried with molecular sieves. In the subsequent liquefaction step hydrogen gas is extracted. Methane, nitrogen and argon are separated by distillation. The by-products methane and hydrogen are processed for ammonia production.

The extracted argon with a purity of 99.999% is stored as a liquid in a vacuum insulated tank at a temperature of -183oC. This liquid argon is then filled into road tanksers and containers. The low temperatures for the process are obtained with a nitrogen circuit incorporating a compressor an expansion turbine and heat exchangers. Due to extremely low temperatures, special care was taken with the insulation of the pipelines and containers.

ARGON - PLANT

capacity : 6900 ton/year




AUXILIARY DIVISION T
Instruments
Electric
Transportation
Mat. testing
Civil
Inspection
Laboratory maint.
Techn. dept. (design & planning)
Central Workshop (450)
Planning (8)
tools & purchasing (3)
wages & personnel (3)
Workshop (188)
vessel constr.& maint.
heat exchang. (57)
valves (20)
mechanic machining (33)
tin-platers (25)
plastic (20)
carpentry (19)
tools (14)
Field (229)
maintenance & erection
machines (48)
pipe & steel I/II/III (85)
internal transport (74)
plumbers (22)

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JOB PROCEDURE

Enquiry (from inside our company or from outside)

Estimate - cost and time

Quotation

Comparison of prices
for new items, very large maintenance jobs

Order (fixed prices)
costs are booked to costcodes (plant, division)
and to costcenter workshop (tools, labour)

Procurement of material and labour
stores
purchasing dept.
hiring of workers

Execution of work
cost: cost bills
cost accounting bill

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M I G - M A G
WELDING EQUIPMENT

With a mig-mag machine, all-metal wires of 0.6, 0.8, 1.0, 1.2 mm Ø are welded under:

CO_2	for carbon steels
mixed gas Corgon 2	for low-alloy steels
argon	for stainless steels, Alu Sl

This system enables us to weld low-alloy steels, stainless steels, aluminium and aluminium alloys.

Equipment: three-phase transformer with constant voltage characteristics ⟶ silicon three-phase bridge rectifier.

Welding current ⟶ direct current (D.C.)

Both processes feature filler metal electrodes, bare wire being machine fed from a reel to melt in its own electric arc.

Only D.C. welding sets and rectifiers with constant voltage characteristics are used (generally: electrode (+) Pol.)

Owing to its high efficiency this process is used to an ever-increasing extent for welding steels.

Wire Ø:

0.3 mm ⟶	desposition rate kg/h ⟶	1.0 - 3.7
1.0 mm ⟶	" ⟶	1.2 - 4.0
1.2 mm ⟶	" ⟶	1.8 - 4.6
1.6 mm ⟶	" ⟶	3.2 - 6.2
2.4 mm ⟶	" ⟶	8.0

WIG - TIG
WELDING EQUIPMENT

TIG process:

Its source of heat is the electric arc burning under a shield of inert gas. Electrodes are either straight or rhenium alloyed tungsten.

The shielding gas is either argon or helium. The gas shields the weld puddle as well as the melting wire from atmospheric action. Only D.C. welding sets and rectifiers are used in the TIG process.

The application range covers sheet fabrication, high quality root runs in tubing and plates. (Generally: electrode - Pol.)

Corrosion resisting steel	D.C. -- electrode negative
High temperature and creep resisting steels	D.C. -- electrode negative
Aluminium	A.C.

INERT GAS WELDING

Principles

With inert gas shielded arc welding, a flow of inert gas protects the electrodes and puddle from the air.

The electrode is either non-consumable and only carries the current and arc, or consumable and is fed constantly to provide filler metal.

This difference accounts for the basic distinction between two types of gas shielded arc welding.

1 non-consumable electrode
   Tungsten inert gas (TIG)

2 consumable electrode
   Metal inert gas (MIG)
   Metal active gas (MAG) if gas mixtures are used

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W E L D I N G   C O N S U M A B L E S   A T   C H E M I E   L I N Z

COATED ELECTRODES FOR MILD STEEL

make: Böhler grade: Böhler	AWS	description - base metal
FOX ETI	E 6013	heavy titan coating, designed for all positions except vertical down; mild steels and pressure vessel steels, up to 33 tons/sq. in. min tensile strength
FOX SPE	~ E 6013	heavy titan coating, for all positions except vertical down; high quality weld in structural steels, storage tank, pipe welds mild steels and pressure steels up to 33 tons/sq.in.
FOX HL 130 Ti	E 7024	titan / iron powder coating designed to give about 130% metal recovery; mild steels and pressure vessel steels, up to 33 tons/sq.in. min tensile strength
FOX HL 150 Ti	E 7024	titan / iron powder coating designed to give about 150% metal recovery; mild steels and pressure vessel steels
FOX EV 50	E 7018	heavy lime-coating type, designed to produce high quality welds; mild steels and pressure vessel steels
FOX EV 60	~ E 8016-G	Mn-Ni alloyed lime-coated electrode; can be used in the temperature range - 80°C → + 400°C

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ELECTRODES FOR WELDING HIGH-TEMPERATURES STEELS

make: Böhler grade: Böhler	AWS	description - base metal
FOX DMO Ti	E 7013-G	Mo alloy titan -coated electrode; mild steels, pressure vessel steels and 1/2% Mo steels, up to 510 N/mm² min. tensile strength
FOX DMO Kb	~ E 7018A1	lime coated
FOX DCMS Ti	E 8013B2	Cr-Mo alloyed titan coated electrode; 1% Cr - 1/2% Mo high-temperature steels, can be used in temperature range up to 550°C
FOX DCMS Ti	E 8018B2	lime-coated
FOX CM2 Ti	E 9013B3	2 1/2 % Cr, 1% Mo alloy titan coated electrode
FOX CM2 KB	~ E 9016B3	2 1/2% Cr - 1% Mo high-temperature steels up to 600°C
FOX CM5 Kb	E 502-15	5% Cr, Mo alloyed lime-coated electrode 5% Cr - 1% Mo high-temperature steels up to 600°C
FOX IN9 Kb	-------	lime-coated, 3% Cr, Mo, V electrode Cr,- Mo-V steels for hot hydrogen service
FOX CN 16/13	-------	lime-coated electrode 16% Cr - 13% Ni+Nb high-temperature steels

A U S T E N I T I C   S T A I N L E S S   E L E C T R O D E S

AUSTENITIC SPECIAL PURPOSE ELECTRODES

make: Böhler grade: Böhler	AWS	description - base metal
FOX SAS 2	E 347-15	lime-coated electrode 18/8 Cr-Ni steel, temp. up to 400°C
FOX SAS-A	~ E 347-16	titan / lime type coated electrode 18/8 Cr-Ni steel, temp. up to 400°C
FOX SAS 4	~ E 318-15	lime-coated electrode 18/8 Cr-Ni-Mo steel
FOX SAS 4-A	~ E 318-16	titan / lime-coated electrode 18/8 Cr-Ni-Mo steel
FOX EASN 25M	----	a low carbon, lime-coated Cr-Ni-Mo type; used in urea plants (mat.n°. 1.4435)
FOX A7	----	a lime-coated electrode for the joint welding of dissimilar steels
FOX AN	----	a lime-coated electrode for the joint welding of dissimilar steels
FOX CN23/12Mo-A	~ E 309MoL-16	titan / lime-coated electrode for welds to join austenitic stainless and carbon steel
FOX CN 29/9	~ E 312-16	universal-type coated electrode for welds to join dissimilar, high tensile steels

COATED ELECTRODES FOR HARD SURFACING
INERT GAS WELDING WIRE

make: Böhler grade: Böhler	AWS	description - hardness
FOX DUR 250		lime-coated electrode for hard and tough buildups, hardness ~ 250 HB
FOX DUR 350		lime-coated electrode for wear-resisting buildups, hardness ~340 - 440 HB
FOX DUR 600		lime-coated electrode hardness: 54 - 58 HRc
Antinit Celsit 50 Nb		cast, ground rod for hardfacing sealing faces on valves hardness: ~ 45 - 48 HRc
FOX Celsit VHL		high-efficiency, alloy powder, titan coated electrode with drawn core for contact face buildups in gas, steam and acid service

		description
Xuper 2240	Castolin	electrode for grey cast iron
Inconel 182 (coated electrode)	Huntington	for shielded metal-arc welding of Inconel Ni-Cr alloy to itself or to stainless or carbon steel. For joining disimilar alloys such as austenitic and ferritic steels to each other and to high-Ni alloys
Inconel 82 (alloyed wire)	Huntigton	
Silox S2	Ögussa	gas welding rod for grey cast iron

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FILLER METAL FOR INERT GAS WELDING

make: Böhler grade: Böhler	AWS	description - base metal
EMK 6	ER 70S-G	a copper coated wire for MAG welding under CO_2 or mixed gas; mild steels and pressure vessel steels
DMO-IG	E 70S-GB	copper-coated, Mo-alloyed wire; mild steels, pressure vessel steels, up to 500°C
DCMS-IG	E 70S-GB	copper coated, Cr-Mo alloyed wire; 1% Cr - 1/2% Mo high-temperature steels up to 550°C
SAS 2-IG	ER 347	bright drawn wire 18/8 Cr-Ni steel
SAS 4-IG	ER 318	bright drawn wire 18/8 Cr-Ni-Mo steel
CN 29/9 IG	ER 312	bright drawn wire for problem steel welding and building up on hot work tools, and for joining stainless to carbon steels.

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GAS WELDING RODS

make: Böhler grade: Böhler	AWS	description - base metal
BW VII	RG 45	a copper-coated, carbon steel wire, low carbon steels fluid puddle
BW XII	RG 60	a copper-coated, Ni-bearing wire viscous puddle low and medium carbon steels
DMO	RG 60	a copper-coated Mo-bearing wire for oxy-acetylene welding medium carbon and low alloy steels; pipes.
DCMS	RG 65	a copper-coated, Cr-Mo alloyed rod; 1% Cr - 1/2% Mo high temperature steels, up to 550°C

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INSPECTION

Law on inspection

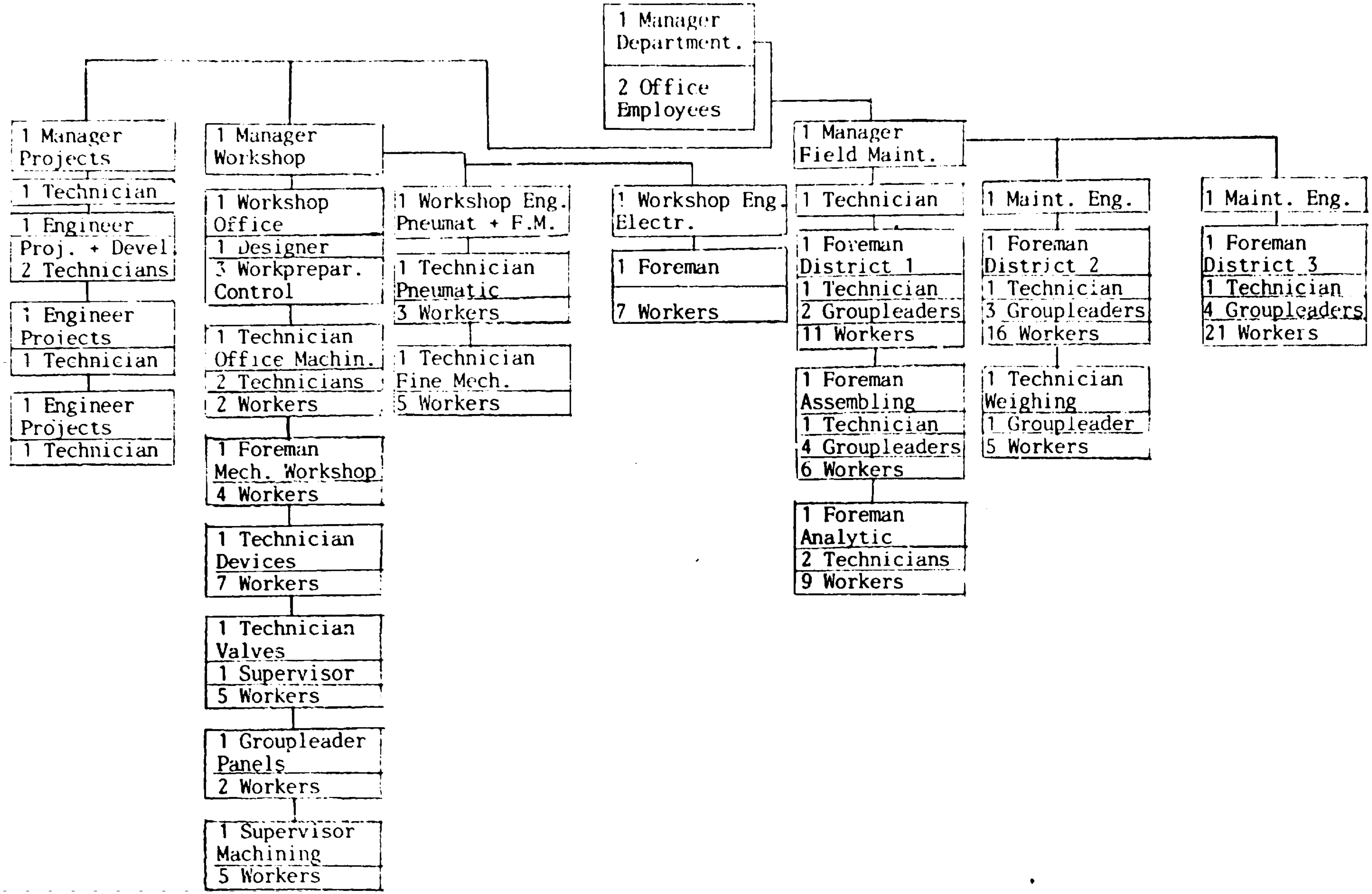
Technical regulations

Inspectors nominated by head of province or county
officers of county
technical supervision association - TÜV

Field of inspection

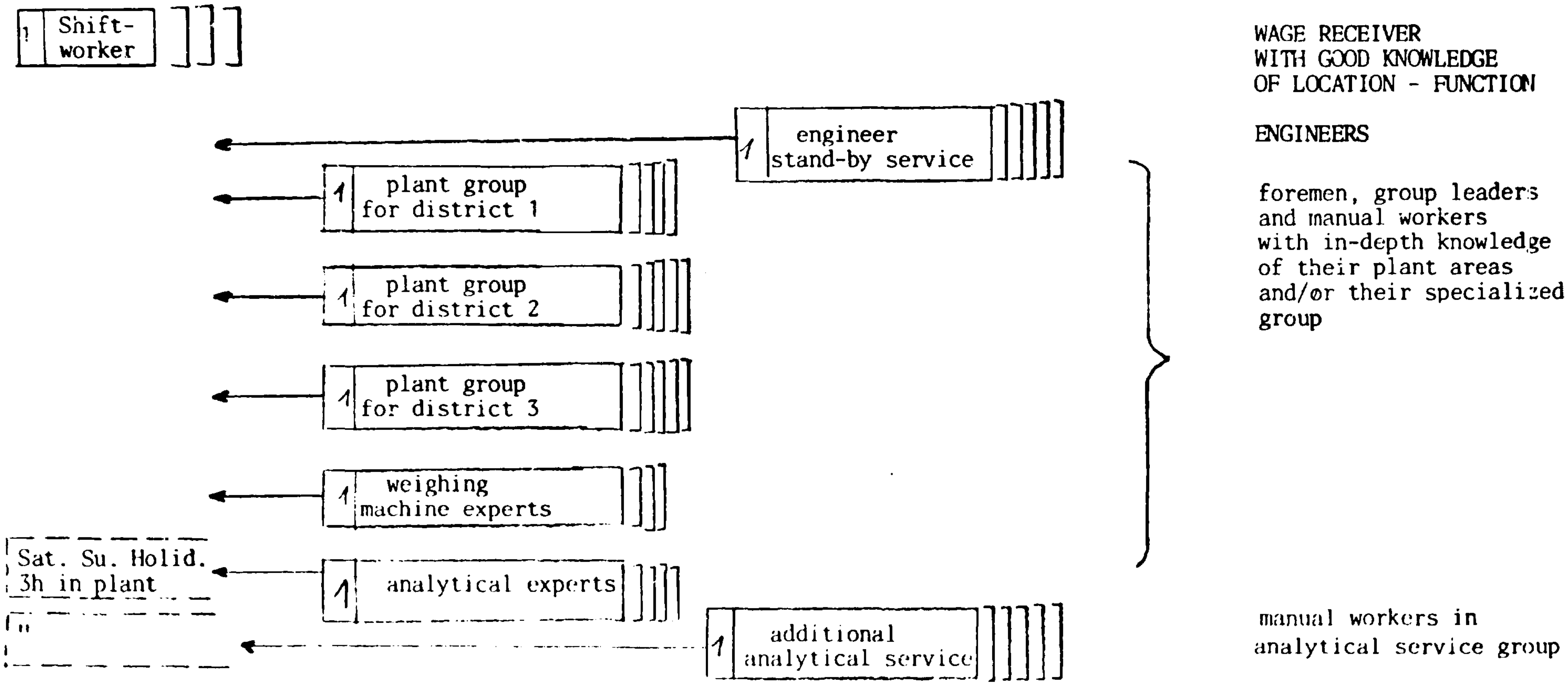
All pressure vessels (1b)
steam vessels (0.5 b)
pipes
valves
lifting devices
cranes
hoists
lifts
safety valves
refrigeration plants

ORGANIZATION OF THE (INSTRUMENT DEPARTMENT)



TME - SHIFT AND STAND-BY SERVICE

Permanently present (call with "fault number")	7 days stand-by service (call via "guide office")	additional analytical service Sat., Sun + Holiday, 3^{h} in the plant	Weekend and holiday stand-by service of eng. (call via "guide office")	QUALIFICATION



SHIFTERS ARE CHANGED YEARLY AND SPECIALLY INFORMED BEFORE SERVICE IN SHIFT
CHANGE OF STAND BY SERVICE AT TUESDAY 6h, SCHEDULE FOR 6 WEEKS IN ADVANCE
INFORMATION FROM "GUIDE OFFICE": VIA TELEPHONE, WIRELESS, TAXI

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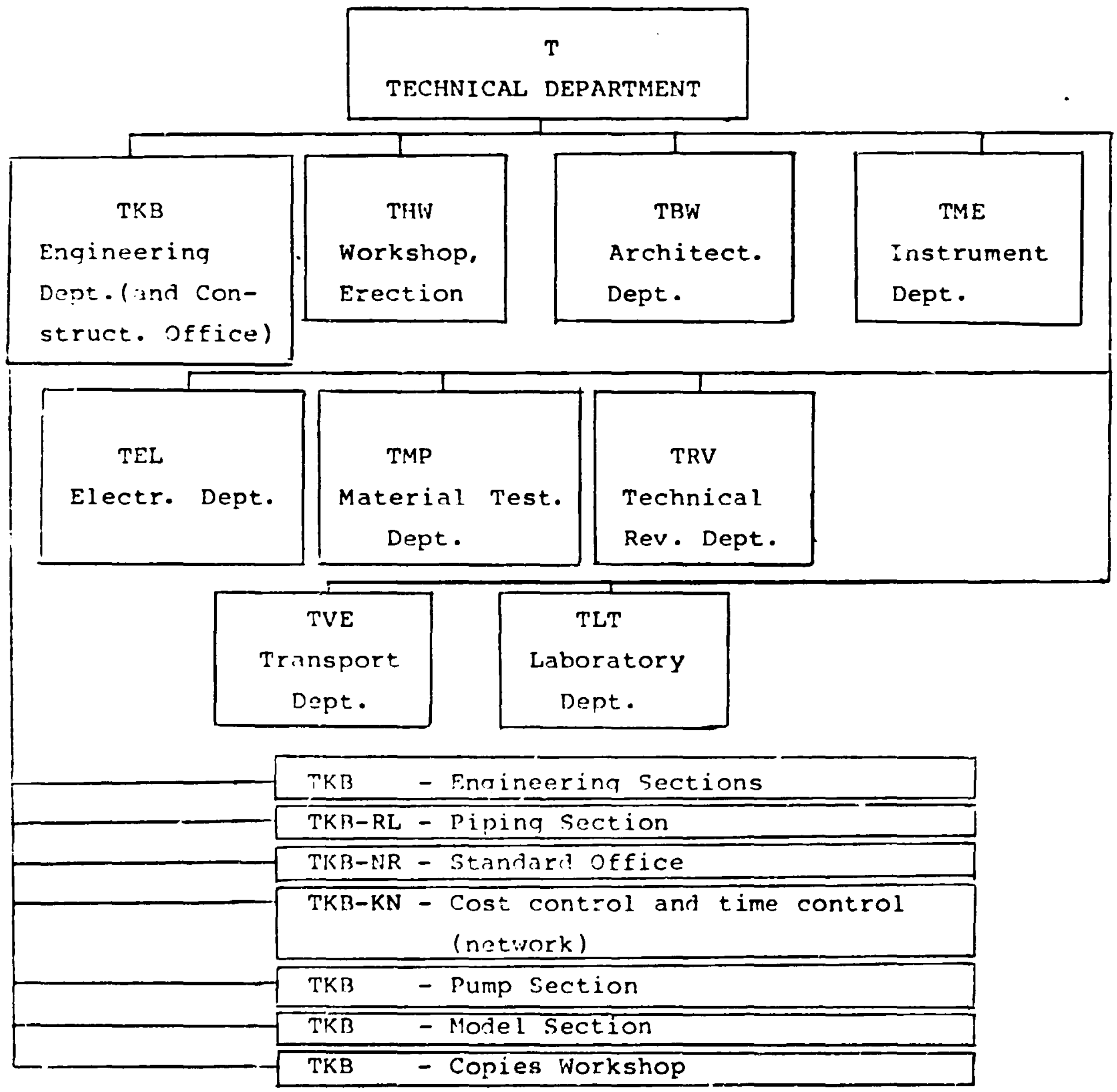
THE ENGINEERING DEPARTMENT OF CHEMIE LINZ AG is a section of the
TECHNICAL DEPARTMENT (T)



ORGANIZATION SCHEDULE -- T E C H N I C A L   D E P A R T M E N T

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Managing Committee

↓

Planning Department

↓

Engineering Department

↓

Activities of the Engineering Department:

Basic Engineering

design basis (see CO2 liquefaction)
basis data of the process (e.g. melamine of urea guide)
process flow diagram (see CO2 liquefaction)
material balance
plot plan
process P and I diagram
time schedule (CO2 liquefaction and urea plant)
project medium key
description of the plant
list of motors and
specifications for the machines and apparatus (e.g. V - 340)
specifications for the instruments
data sheets (A/B 6)
costing for the project

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Detail Engineering

P and I flow diagram (see CO_2 liquefaction and instrument symbols)
quotation for machines, apparatus, pipes, etc.
orders for machines, apparatus, pipes, etc.
plant model
pipework isometrics
measuring and regulation (control) diagram
checking of the orders
checking of the workshop drawings
orders for erection
manual handbook
commissioning and test run
control of the project costs and control of the time schedule
(e.g. melamine plant, urea plant)

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INSTRUMENT SYMBOLS

the letters mean:

	in first place	in second place	in third or subsequent place
A	analysis	alarm	alarm
B	conduction	controller	controller
D	specific gravity	-	-
E	-	element	-
F	flow rate	-	-
G	-	glass	-
H	remote control by hand	-	-
I	-	indicator	indicator
L	level	-	-
M	moisture	-	-
P	pressure	-	-
R	-	recorder	-
S	number of revolutions	circuit	circuit
T	temperature	-	-
V	viscosity	-	valve
W	weight	shell	-

plus:

d ... difference

h ... mech. thermometer

r ... proportion

pH ... pH value

Q ... counter

AH ... alarm high

AL ... alarm low

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SCOPE OF SUPPLY FOR EXTENDED BASIC ENGINEERING

The following documents will be supplied according to a time schedule to be agreed upon for the procurement, construction and acceptance of the plant and its elements. All documents will be kept up to date and will be elaborated in German language (possibly English) according to the metric system (international system of units acording to DIN 1301). Symbols or designations shall correspond to Chemie Linz AG standards, to Austrian standards or DIN standards with respect to the Chemie Linz AG short designations. Doçuments will be submitted in the form of prints and one reproducible each.

P) Process Flow Diagram with quantities of the materials and their composition within the different phases of the process, operating data, thermal balance, consumption of raw materials and energy yields. Above data will be indicated for minimum, normal and maximum throughput description of the process.

b) Draft layout indicating platform loads (forces, weights and moments) and ceiling break throughs, according to which construction drawings can be prepared. Final installation drawings, foundation drawings, indicating weights, forces and moments.

c) Piping and Instrument Flow Diagram with all process and energy pipe networks comprising all machines, apparatus, fittings as well as measuring and regulating equipment. The diagram will be established in such a way that the relation between process flow diagram, installation drawings, model, isometrics and measuring and regulating diagram will be clearly shown. As far as possible the dimensions and levels of apparatus and machinery will be shown according to scale. Material data lists, media codes, classifications for pipework, fittings and seals.

d) Specifications (descriptions and dimensional sketches, data for the pipe connecting sockets, i.e. quantity, nominal widths and nominal pressure, material, static and dynamic loads, permissible loss, amounts of heat, temperature, pressure and the like) for all machines and apparatus including required steel structures herefore, if any, to permit relevant design drawings to be prepared and/or the equipment to be built. Workshop drawings with parts lists of equivalent documents with apparatus data or apparatus details for equipment which require special design.

e) Plant model on a scale of 1:25 (details possibly 1:10) consisting of structural framework with stairs, platforms and ladders, all apparatus and machines, pipe bridges, process and energy pipework, main routing of measuring and regulating lines as well as of electric cables.

f) Pipework isometrics with parts lists for all pipelines with fitting lengths in all three levels. Indication of sliding and fixed points and/or determination of pipe supports indicating static and dynamic values as far as they have to be specified by the engineering company. Determination of pipe connecting sockets on the apparatus in plan form with level indication. Provisional list of materials at the beginning of planning for the complete pipework including fittings and accessories. Specifications for special pipe material not yet included in the documents of Chemie Linz AG.

g) Specifications for insulation and painting of machines, apparatus, pipework and steel structures.

h) Measuring and regulating (control) diagram with specification list for the measuring and control devices with indication of nominal values, measuring and regulating (control) range and relevant permissible deviations, information on material coming in contact with the media as well as indication of physical values (pressure, temperature, density, viscosity, etc.) safety settings for the regulating and/or control fittings, interlock diagram and alarms for the instrumentation of process engineering. This documentation must be detailed enough to permit ordering of the corresponding equipment items.

i) Specification of electro-technical equipment.
Draft of distribution system (one-line diagram), provisional motor list, power mains and lighting facilities. Summary of critical points in regard to explosion proofing (drawing of explosion hazard zones) control and interlock and alarms.

k) Checking of our drawings and of technical order specifications for all plant equipment from the process engineering point of view.

l) Description of the plant, start-up and operating instruction, control and analysis procedures.

m) Commissioning and test run by competent persons of the engineering company.

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TIME-TABLE FOR THE DELIVERY OF THE PARTICULARS FOR AN ENLARGED BASIC ENGINEERING

	months
Process Flow Diagram and process description -	......
Draft layout with waste gas and waste water particulars -	......
Final installation drawing one month after receiving the last particulars -	......
Simple Piping and Instrument Flow Diagram (Process P and I Diagram) -	......
Piping and Instrument Flow Diagram (P and I Diagram) -	......
Media codes, classifications for pipework, fittings and seals -	......
Provisional list of materials for the complete pipe material -	......
Specifications for equipments with longer terms of delivery (reactors, compressors, etc.) -	......
Specifications for equipment with the shortest terms of delivery -	......
Plant model -	......
Pipework isometrics with parts lists -	......
Specifications of the measuring and regulating devices -	......
Provisional motor list -	......
Draft of the electric distribution systems -	......
Plan for explosion and hazard zones -	......
Control and interlock diagram and alarms -	......
Start-up and operating instructions (operating instruction manual) -	......

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CHEMICAL WASHING (PICKLING) OF

1. Pipelines
2. Natural Circulation Boiler
3. Storage Tanks

General: At Chemie Linz all pickling treatments were done by a pickling contractor:

Therm-Service GmbH
D-7035 Waldenbuch
Bahnhofstr. 34
West Germany

other contractors are:

Keller & Bohacek
D-4000 Düsseldorf-Rath
Liliencronstr. 64
West Germany

Deutsche Derustit GmbH
D-6057 Dietzenbach
Emil von Behring Str. 4
West Germany

Röhsler & Co.
A-1230 Vienna
Gebirgsgasse 24
Austria

ad. 1. PICKLING OF PIPELINES

a) Thrust through system

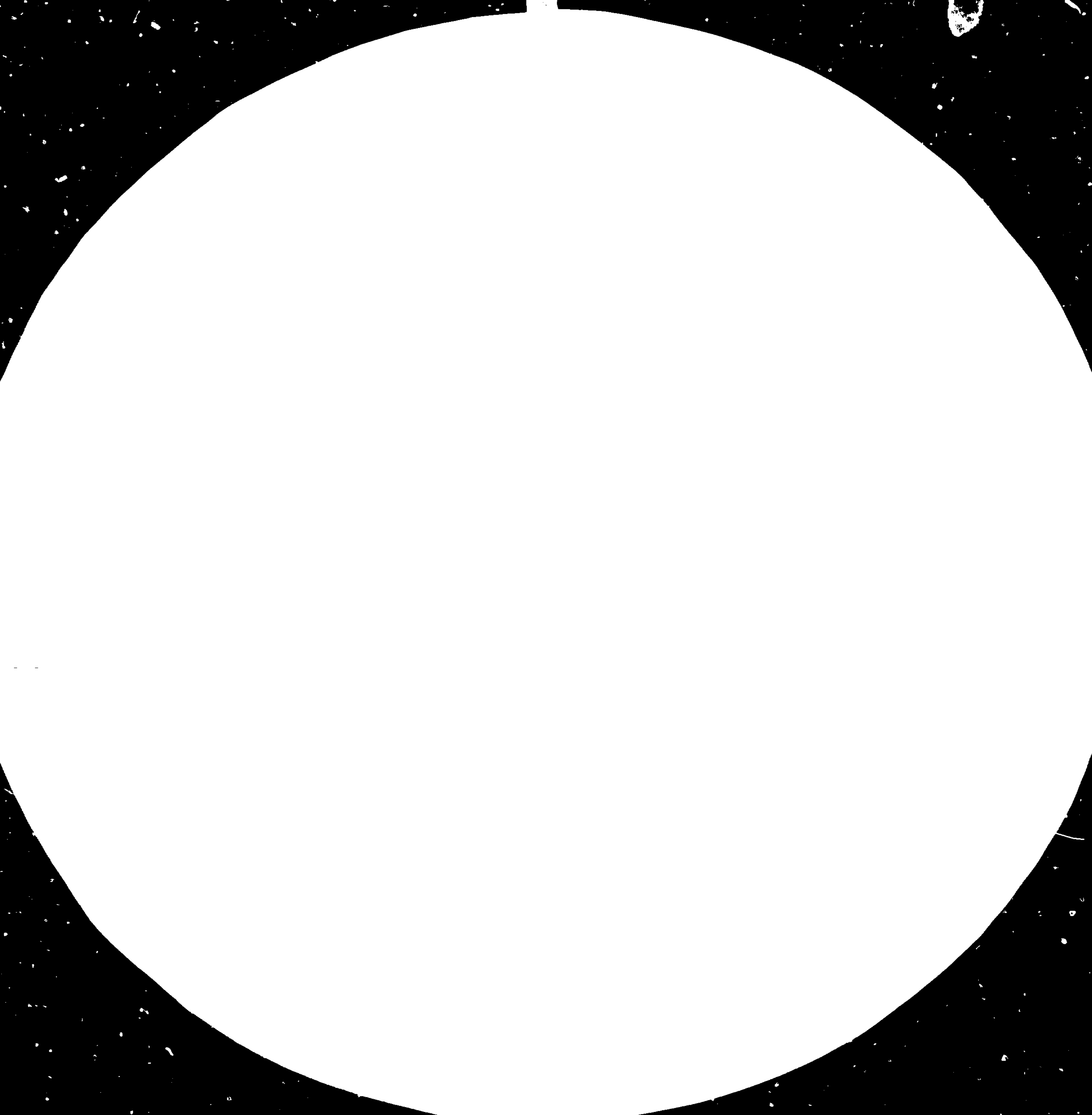
This method was used for the long pipes on the pipe bridges. There the pickling solution (e.g. hydrofluoric acid) was injected into a temporally limited water-flow.

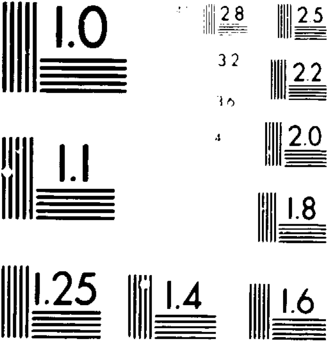
b) Closed circuit system

This system was used for pipes temporarily connected to closed circuits. See fig. 1.
All valves were left installed.
Hoses, pumps, mixing tank with steam heating and some valves were contractor's account.

During the design of the pipes there should be a communication with the pickling contractor to set the right nozzles and flanges in the pipes for filling pipes with pickling solution. So you can pickle the pipes every time again after repairing the pipes.
Before asking a pickling contractor you should know the diameter nominal, length, volume and the inside surface of the pipes (area) you want to have pickled.

Before pickling all pipes ready have to be welded and water pressurized. If you had not done this before there would be new surface oxidation.





MICROCOPY RESOLUTION TEST CHART

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Performance procedures at Chemie Linz AG

a) flushing with water

b) degreasing in addition with ion-neutralized solution.
   t = 60 - 80 oC

c) pickling with a solution of 1 % inhibited hydrofluoric acid.
   t = 40 - 50 oC

d) stabilization with a 0,1 % solution of citric acid

e) passivation in addition with ammonia and H2O2 until the pH of effluent was 10,2

f) after drainage of the system the surface was dried and prssurized with nitrogen

The effluent solution was neutralized with lime ($Ca(OH)_2$) to the required pH.

Time required

This procedure needed the following times (without preparation time):

flushing	- a)	some hours
degreasing	- b)	12 hours
pickling	- c)	5 hours
stabilization	- d)	14 hours
passivation	- e)	24 hours

ad 2. PICKLING A NATURAL CIRCULATION BOILER

acts:

steam volume:	40 t/h
pressure:	42 bar
temperature:	450 oC
volume of the water tubes:	22,5 m3

(without economizer and superheater)

Pickling by the auto-circulation system

The performance procedures were the same as described for pickling the pipes with the closed circuit system.
To have the required pickling speed, air was blown through lances into the downcomers.
The auto-circulation is caused by inserting air-lances into the tubes. The lances were taken through the upper water drum into the tubes.

Pickling storage tanks (see fig. 2)

These tanks were pickled with a 4 - 5 % solution of cold hydrochloric acid.

Blowout of high-pressure steam pipes from the boiler to the turbine (see fig. 3)

After chemical cleaning, the pipes were blown out with steam which was generated in the boiler.
There we tried to achieve a high steam speed in the long pipe (400 m/s). So we had good mechanical cleaning.

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STRESS ANALYSIS OF PIPING SYSTEM

Basic steps of calculation:

1. Procedure of design starts with making a freehand isometric piping sketch.
2. Spot preliminary locations of hanger or supports, locate hangers at or near any concentrated loads (heavy valves, risers,...). Pick up all horizontal bends, to prevent any excessive overhang. Hanger spacing must be close enough to prevent excessive sagging.
3. Study building steel.
4. Check for interference (pipes, constructions)
5. Calculate distribution of weight - important to obtain zero load at equipment flange.
6. Summarize hanger loadings.
7. Calculate distribution of expansion to hanger.
8. Calculate distribution of equipment movement.
9. Summarize movements.
10. Choose hangers or supports for loadings and movements.

CHEMIE LINZ MELAMINE PROCESS

PROCESS DESCRIPTION

Melamine, a raw material for the plastic industry, need to be produced from calcium cyanamide via dicyandiamide, but is now mainly produced from urea.

Chemie Linz AG succeeded in developing a continuous process at atmospheric pressure for the production of melamine from urea, thus achieving technical progress and solving all problems satisfactorily.

The Chemie Linz AG Melamine Process operates at atmospheric pressure. The formation of melamine proceeds - in the same way as with all other processes starting from urea - according to the overall equation

$$6\ CO(NH_2)_2 \longrightarrow C_3N_3(NH_2)_3 + 6\ NH_3 + CO_2$$

The reaction is endothermic.

The melamine is produced in two steps. First, urea is thermally decomposed into an equimolar mixture of isocyanic acid and ammonia:

$$CO(NH_2)_2 \longrightarrow HNCO + NH_3$$

H = + 780 kcal/kg urea (solid), endothermic reaction.

This gas mixture is diluted with additional ammonia and fed to a catalytic reaction. During this second step the isocyanic acid is converted into melamine and carbon dioxide.

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$$6\ HNCO \longrightarrow C_3N_3(NH_2)_3 + 3\ CO_2$$

H = - 714 kcal/kg melamine, exothermic reaction.

These separate process steps permit carrying out each reaction within the optimum temperature range. Consequently the formation of unwanted by-products is reduced to a minimum; and a recrystallization is not necessary.

The first reaction takes place in a heated fluidized sand bed. There is practically no abrasion and therefore the reaction gases need not be filtered. The second reaction is effected in a fixed catalyst bed. There is no contamination of the product gases due to catalyst dust. Such contamination would necessitate filtration and crystallization. The reaction heat is used for preheating ammonia. The melamine formed in the catalyst bed is gaseous at reaction temperature. It is condensed in a subsequent cooler, where melamine crystals are formed in an aqueous suspension. The remaining components of the reaction gas mixture can thus be separated from the suspension very easily.

The melamine can be easily separated from the mother liquor by a centrifuge or a filter. Due to this wet separation and the subsequent drying melamine with high bulk density is obtained. High bulk density is an advantage for storage, transport and further processing.

According to the overall equation 2.86 tons of urea are theoretically needed for the production of one ton of melamine with 0.81 tons of ammonia and 1.05 tons of carbon dioxide as by-products.

As the formation of melamine from isocyanic acid has a yield of 91 - 95 %, 3.1 tons of urea are required to produce one ton of melamine in practice.

The unreacted isocyanic acid is hydrolized into ammonia and carbon dioxide or formed into urea.

PROCESS DESCRIPTION OF A MELAMINE PLANT

If the urea to be treated is available in solid form this is first melted with steam (1,2). If urea is available in liquid form there is of course no need to melt it. The melt is delivered to the decomposer (3) by pumps. The heat required to decompose the urea is obtained from a circulation salt bath which is maintained at the right temperature. The reaction takes place in a sand bed reactor, fluidized with hot ammonia. In the decomposer (3) a gas mixture, consisting of isocyanic acid and ammonia, is formed. This is delivered to the catalyst reactor (5), where the isocyanic acid is converted to gaseous melamine, and carbon dioxide is set free. The reaction heat is used to preheat ammonia.

The mixture of gaseous melamine, ammonia and carbon dioxide goes to the separator (6) where fine crystalline melamine suspended in water is obtained by direct cooling.

Due to extraction of heat by water evaporation the separation gases entrain water vaporous. A great part of this water vapour is condensed in the following off gas cooler (7) and returns to the separator (6). The off-gas is sent to the off-gas treatment unit.

The suspension from the separator (6) is pumped into a collecting tank (8) and cooled via cooler (9), whereby part of the dissolved melamine crystallizes out.

The suspension is pumped to the centrifuge or filter (10) where melamine crystals and liquid are separated. The mother liquor is recirculated to the melamine separator where it serves as a cooling agent.

To obtain the desired moisture in the final product the melamine from the centrifuge or filter is dried in drier (11). The cooling zone in the drier cools the melamine so as to be suitable for storage.
The sieve (12) and mill (13) beyond enable removal of agglomerates formed in the drier.

The product from the drier is ready for sale. It is weighed (14), bagged and stored.

Off-gas utilization

The off-gas consists of carbon dioxide, water vapour, inert gases and a lot of ammonia. The major part of this ammonia was fed to the catalytic reactor in the synthesis for the fluidization. The minor part was set free during reaction.
There are different alternatives available for utilizing the off-gas and mother liquor economically.

The following possibilities may be mentioned:

a) Separation and return of the ammonia from the synthesis and absorption of the residual off-gas to produce an ammonium carbonate solution. This carbonate solution can be delivered to fertilizer plants for conversion into ammonium nitrate, ammonium sulphate or ammonium phosphate.

When passing this ammonium carbonate solution to an urea plant consideration should be paid to the fact that the hight percentage of water reduces the efficiency of conversion into urea.
An improvement is obtained through conversion of the ammonium carbonate into an ammonium carbonate solution, thus reducing the water rate.
A better alternative would use a process, developed by Chemie Linz and used in serveral plants.

b) Obtain an ammonium carbonate solution as in a) above and separate this into ammonia, carbon dioxide and water, with only marginal increase in investment and utility requirements. Thus the melamine plant is independent of any other plant because the pure ammonia can be exported in liquid form or used anywhere.

PROCESS DESCRIPTION OF AN OFF-GAS TREATMENT UNIT

The off-gas goes to the ammonium carbonate column (=NH3-separation, 21) where CO2 is washed out forming an ammonium carbonate liquor supersaturated with ammonia. The surplus of ammonia is cooled and dried with liquor ammonia on the top of the column. The bulk of this ammonia is compressed (16), preheated (4) and returned directly to the melamine plant for re-use. A small part of this ammonia stream is further compressed (17), liquified (18), separated from residual inert gases and fed to the top of the ammonium carbonate column (21).
The balance of the ammonia gas obtained at the top of the column (21) leaves the plant and is available for further use in other units. This quantity corresponds to the ammonia produced during the melamine synthesis.

The ammonium carbonate solution is stripped off from the free ammonia in the NH_3 stripper (15) and delivered to the lower stage of the CO_2 stripper (19), which operates under elevated pressure. In the lower steam-heated stage the ammonium carbonate solution is decomposed. In the upper stage the NH_3 is scrubbed with water and the pure CO_2 leaves the plant for further use. The ammonia water obtained in the sump, which still contains slight amounts of carbon dioxide, transfers its heat in the NH_3 CO_2 stripper (20). A high proportion goes to the ammonium carbonate column (21). The remainder is decomposed in the NH_3 CO_2 stripper (20). Gases expelled in this column are recycled to the ammonium carbonate column. The separated water can be used as washing water or purged.

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CONSUMPTION FIGURES PER TON (METRIC) OF MELAMINE

Consumption		Expected	
Urea (100 %)		3.10	t
NH_3 liquid		0.3	t
Process water (condensate)		1.2	t
Catalyst			
(2 years' life)		2.5	kg
Electric power	6 kV	500	kWh
	500 V	280	kWh
Fuel		14.4	Gj
Steam	15 bar	3.0	t
	6 bar	4.0	t
Cooling water	15 oC	800	m3
Nitrogen	5 bar	40	Nm3
Instrument air		40	Nm3
Compressed air		400	Nm3

Credit			
NH_3 gas	1 bar	1.2	t
CO_2 gas	20 bar	1.1	t
Condensate		5.0	t

Effluent		
Mother liquor from recrystal	0.03	m3
with 1 kg melamine		
20 g NaOH		
90 g Na-ammelide		
	0.03	m3
Cooling water	800	m3

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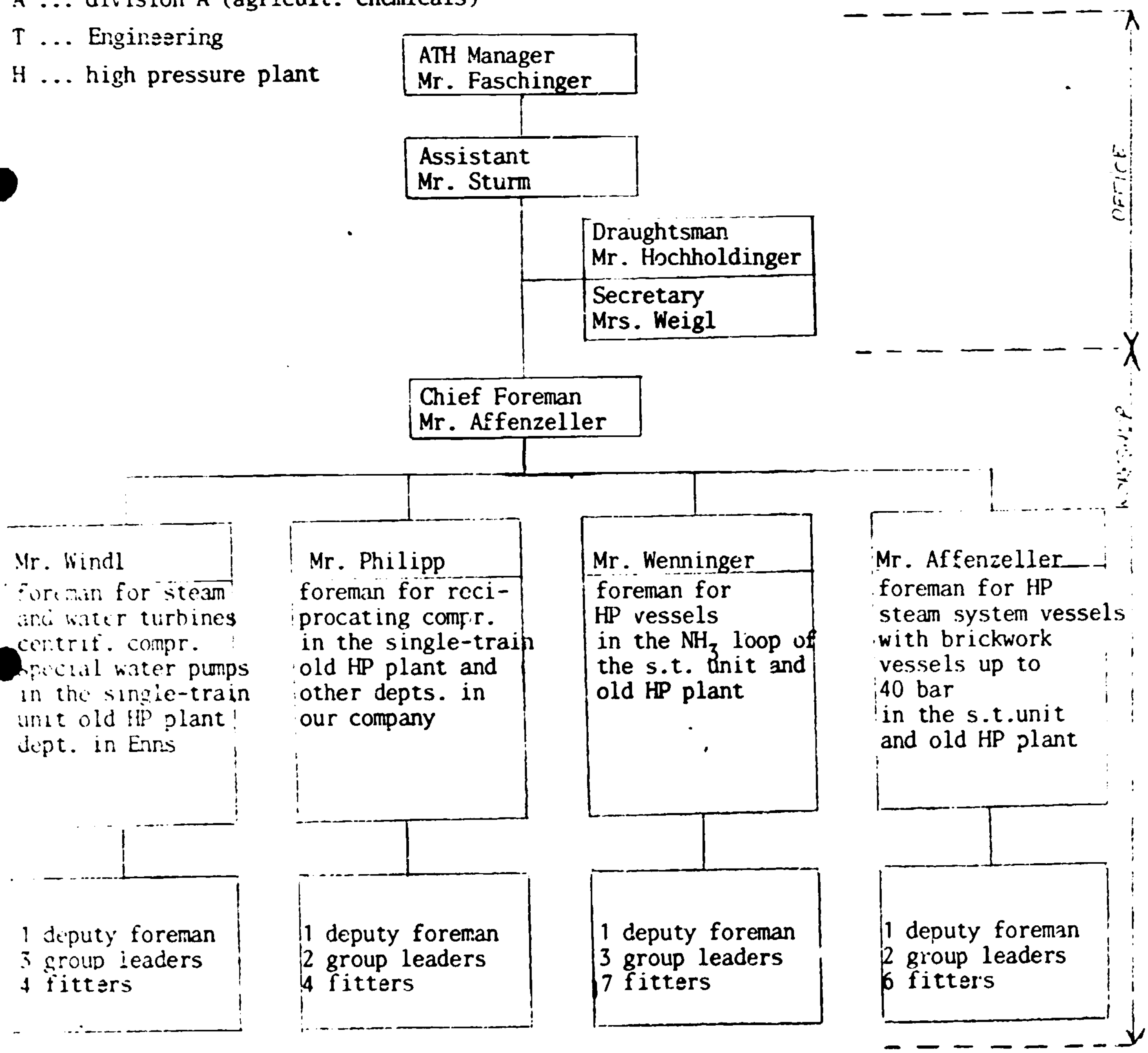
ORGANISATION DEPT. ATH

A ... division A (agricult. chemicals)
T ... Engineering
H ... high pressure plant



The foremen are allocated to defined jobs.
The workers can be shifted between the 4 foreman groups if necessary.

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RESPONSIBILITY OF DEPT. ATH

Maintenance of the existing ammonia single-train unit and old HP plant in the best way (good performance, low cost, short time).

Improvement and rationalization of the different facilities and processes.
Preventing of accidents.
Control of maintenance costs.
Working out of shutdown programs.
Co-operation with different departments concerning expansion of existing plants and installation of new plants.
Good contact with production personnel and some central departments (central workshop, electrical dept., instrument dept., civil dept., design, safety, ..)

<u>Stand-by service from Friday to Monday</u>

1 engineer or foreman
2 fitters

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HISTORY OF AMMONIA PRODUCTION PLANT (ATH)

1942: start of ammonia production at 75 000 t N per year with 4 units, each with 80 t N per day

1966: expansion to 300 000 t N per year

1975: start up of ammonia single-train unit
design target: 200 000 t N/year
1978: 242 000tN/year (we had a general overhaul lasting 6 weeks)

Due to good operation and good maintenance the percentage running time of all our facilities is very high.

(100% = 365 days per year)

e. g.: reciprocating compressors 99,5%
general revision every 45 000 hours = 5 years

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SINGLE-TRAIN UNIT MAINTENANCE

Design target for the unit: 240 000 t/year NH3, i.e. 850 t/day NH3.

February 1975: start up of ammonia production

<u>Production figures</u>

1975	200 000 t/year NH3
1976	262 000 t/year NH3
1977	290 000 t/year NH3
1978	294 000 t/year NH3
1979	334 000 t/year NH3
1980	291 000 t/year NH3
1981	288 000 t/year NH3
1982	304 000 t/year NH3

daily production now: 1 000 t NH3

For maintenance we needed:

	hours	material (Mio. AS)
1975	117 000	11.2
1976	34 000	5.0
1977	60 000	7.1
1978	108 000*	10.0*
1979	40 000	1.6
1980	90 500**	4.8**
1981	101 500***	
1982	37 000	

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*) 1978: first general overhaul

**) 1980: shutdown to replace catalyst in primary reformer.

***) 1981: was the 2nd general revision

For this reason we needed:

	hours	material (Mio. S)
*)	67 000	7.0
**)	50 000	3.0
***)	58 000	8,3

The investment cost for the single-train unit was about AS 500 Mio. in 1974.

On stream days: <u>Syngas production</u> <u>NH3 production</u>

	Syngas production	NH3 production
1975	280 days	217 days
1976	317 days	294 days
1977	335 days	321 days
1978	326 days	313 days
1979	362 days	355 days
1980	328 days	310 days
1981	328 days	308 days
1982	365 days	361 days

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DEVELOPMENT OF SYNGAS COMPRESSORS OF SINGLE-TRAIN PLANTS

The first Single-Train plant (designed by Kellog) incorporated syngas centrifugal compressors which were developed by Clark. The pressure in the ammonia reactor was fixed at about 160 bar. To reach such a pressure Clark designed compressors with two cases. The speed was approximately 10 000 rpm.

To improve the efficiency of ammonia synthesis it was necessary to increase the pressure in the ammonia reactor. Nuovo Pignone, BBC, Cooper-Bessemer and Clark designed compressors which reached a pressure of 320 bar.

One of the problems of high-speed centrifugal compressors is their low weight, compared for example with reciprocating compressors.

The pipelines to and from the compressor have large diameters, and pressures are high.

Therefore it is very important to prevent forces of reaction affecting the compressor. This is also a very important point for steam turbines. The reaction force of steam pipelines is - owing to the high temperature of steam (500oC) - very large. In our plant we did not have satisfactory experience with "pipeline carriers with springs" because the reaction force of the spring depends on the spring constant.

So we envisaged carriers held by weights. This kind of carrying pipelines needs more space, the advantage is to have constant forces applied to the pipelines.

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EXPERIENCE IN SEALING THE 4TH STAGE OF THE SYNGAS-COMPRESSOR

After having operated our syngas compressor for half a year we had to take the compressor out of operation due to increased oil consumption. Removing the seals we noticed that the seals on the recycle side were still intact but on the syngas suction side the high-pressure sealing was damaged. The white metal was melted and the O-ring was embrittled.

Enclosure 1 shows how the seal consumption increases.
In enclosure 2 the operating conditions of the seals are shown.
A drawing of the seals with dimensions is shown in enclosure 3.

In enclosure 2 it is obvious that on 7.9, 9.9 and 12.9 the seal oil temperature TI 6025 had increased.

Except for this temperature no other disturbance was noticed. The result of analysis of the residuals found on the sealring in the case of the compressor and in the automatic oil separator was that the residuals were not breakdown products of the oil.

The residuals (zinc dithiophosphate) are produced in a reaction between oil and ammonia at the existing high pressure.

After having repaired the compressor we had a seal oil consumption between 1 and 5 litres per day.

The embrittled O-ring material was iron. But viton is not resistant against ammonia and we changed it to Silikon with success.

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To avoid the formation of zinc dithiophosphate Nuovo Pignone made the following arrangement:

1. To install a connection between syngas discharge and balance gas.

2. The pressure in the balance gas should be kept about 0.5-1 bar higher than the syngas suction pressure. Through this improvement the pressure of ammonia in the reference pipe is reduced .

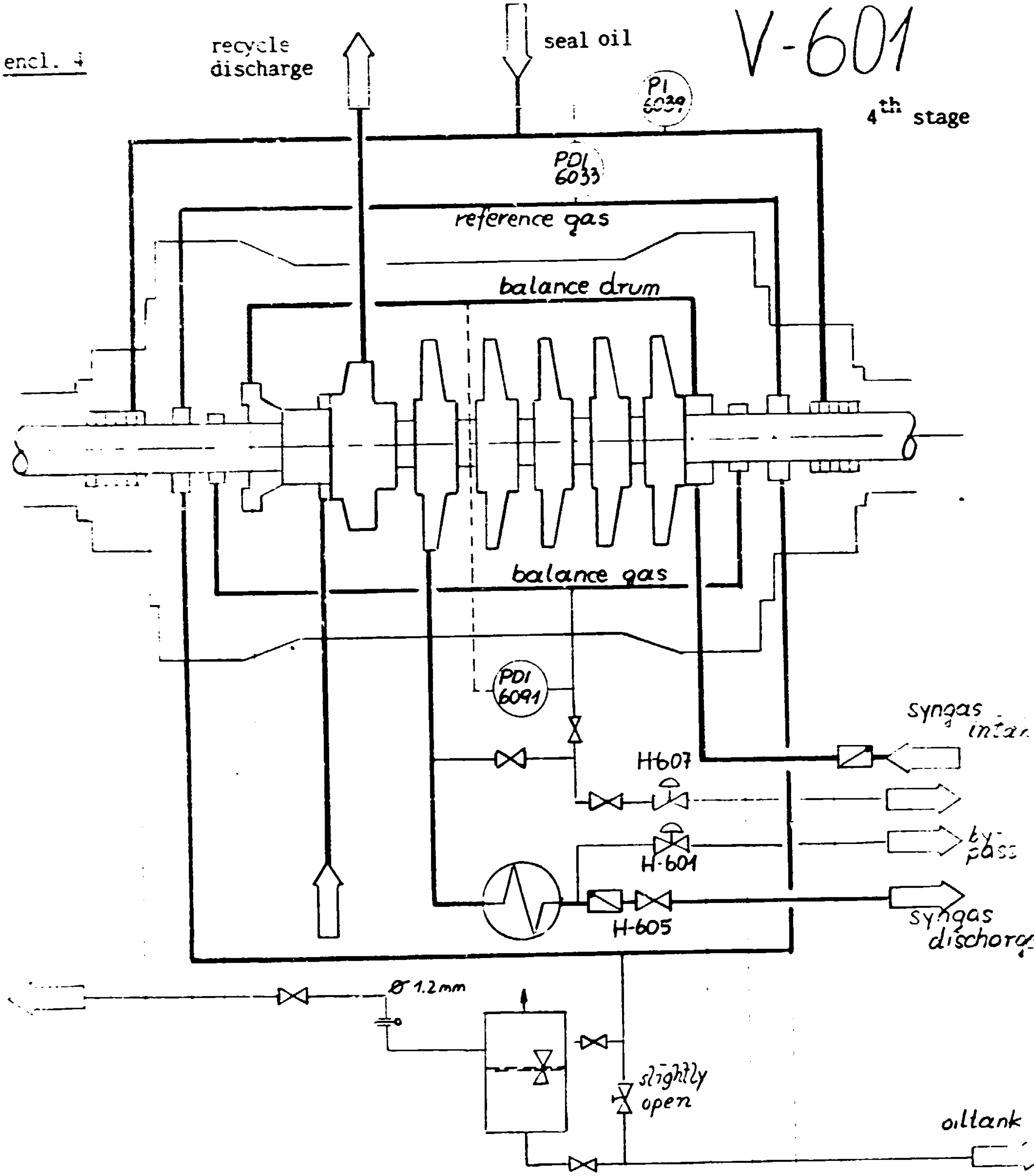
After having installed this connection pipe we did not have any difficulties with the seals in the 4th stage. Care must be taken that the quench gas in the connection pipe has a temperature lying higher than the dew point of the gas.

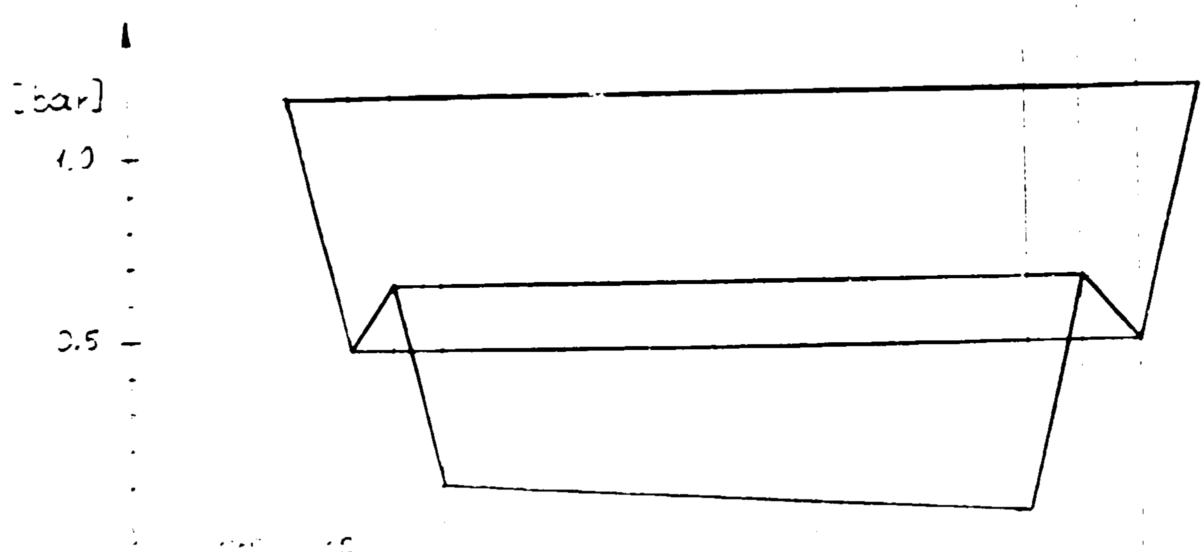
If the temperature is below the dew point the labyrinths could be damaged by erosion.

The arrangement of the quench gas pipe can be seen in enclosure 4.

encl. 4

V-601


recycle discharge
seal oil
PI 6039
4th stage
PDI 6033
reference gas
balance drum
balance gas
PDI 6091
syngas
H607
by-pass
H-601
H-605
syngas
Ø 1.2mm
slightly open
oiltank


[bar]
0.5

● ... ALLOWED
○ ... ALSO POSSIBLE
X ... NOT ALLOWED

TOOL:		WORK IN VESSELS AND IN NARROW SPACES	ON METALLIC CONDUCTIVE POINTS (GRID, STEEL CONSTRUCTION)	ON GOOD CONDUCTIVE POINT (SOIL, CONCRETE)	ON POOR CONDUCTIVE P... (WOOD, ETC.)
LOW VOLTAGE 42 V	42 V — 42 V NET	●	●	●	●
ISOLATING TRANSFORMER AND ELECTRIC HAND TOOL WITH TERMINAL OF PROTECTING WIRE AND VISIBLE ...ED STAND-POINT CONN.	380 or 220V — PORTABLE DISCONNECTING TRANSFORMER	●	●	○	○
ISOLATING TRANSFORMER AND ELECTRIC HAND TOOL WITH PROTECTING WIRE TERMINAL	380 or 220V — PORTABLE	X	X	●	○
ISOLATING TRANSFORMER AND ELECTRIC HAND TOOL WITH PROTECTIVE INSULATION	380 or 220 V — PORTABLE	X	X	●	○
ELECTRIC HAND TOOL WITH PROTECTIVE INSULATION AND FAULT CURRENT SWITCH	380 or 220 V — 380/220V FJ	X	●	●	○
ELECTRIC HAND TOOL WITH PROTECTING WIRE TERMINAL	380 or 220 V	X	X	X	●
ELECTRIC HAND TOOL WITH PROTECTIVE INSULATION	380 or 220 V	X	X	X	●
HANDLAMPS	42 V — 42 V NET	●	●	●	●
ISOLATING TRANSFORMER ... FIXED MOUNTED ... LAMPS 220 V	220 V	●	●	●	○
FIXED MOUNTED 220 V-LAMPS WITH PROTECTIVE INSULATION AND FAULT CURRENT SWITCH	220 V — FJ	X	●	●	○
LOW VOLTAGE CONCRETE VIBRATORS	42 V — 42 V NET	●	●	●	●
ISOLATING TRANSF	380 or 220V — PORTABLE	x	x	●	●

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TECHNICAL EXPERIENCE WITH THE BENFIELD SYSTEM

1. Low-pressure pumps P 401/402 for Benfield solution

When starting our plant we noticed that the low-pressure pumps developed a noise. We suspected the reason for this noise to be cavitation.
Although we checked the pump in the presence of Worthington experts we could not find any indication of cavitation.

We insisted on the warranty being prolonged for a further year by Worthington.
Worthington' s expert agreed to this, and explained the noticed noise with circulation.

Before the extended warranty had elapsed we checked the impeller once again very exactly, but no sign of cavitation was found.

When we had to change the seal rings three months later we noticed the first indications of cavitation - the back of the blades were galled.

Steps for solving this problems

a) welding the galled surface with electrodes consisting of hardfacing alloy,

b) introduction of 3 - 4 m3/h nitrogen into the suction pipe of the pumps.

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We have two low-pressure pumps for Benfield solution. In the suction pipe of one of these pumps there are two elbow pipes. At this pump we found cavitation only on one side of the double fluted impeller.
The suction side of the second pump is connected to a tee in the main suction pipeline.
At this pump we found cavitation on both sides of the impeller after only 4 200 working hours.

Our engineering firm, Uhde, found out that the noise of the pump disappeared when the pump was operated at 115% of the normal flow rate.
When the flow rate was reduced the noise increased. This symptom was also an indication that the noise was caused by circulation.

2. High-pressure pumps P 403/404

Washing and cleaning our plant during start up revealed that the seals were contaminated with dirt. So we had to replace them from time to time.

After plant start up it was not necessary to change the packings for about one year. But after this time we had a lot of problems with the Pacific seals. Sometimes we had to change the rings after as little as one week.
We found out that the spare rings supllied by Pacific were not flat and full of cracks.

Up till then the seal rings had been greased with Benfield solution. Having such a lot of problems with seals we changed the medium for greasing the seal rings and used condensate with a temperature of 65 - 70oC.

Condensate of such a temperature is more qualified for greasing seals than Benfield solution.

The pressure of the condensate has to be a little bit higher than the intake pressure of the pump.
To make this improvement it was necessary to install a condensate cooler and a controlling system.
Since we started operating with this modification the seals have to be changed approximately once a year.

3. Efficiency of the CO_2 removal system

After having started our plant we did not obtain the efficiency of gas purification guaranteed by Uhde. After a lot of difficulties investigations we found out that the bad distribution of potassium carbonate solution was the reason for our problems. By installing baffles we improved the distibution of Benfield solution to the ceramic intalox.
The efficiency of purification increased after this modification. Finally we installed two redistributers in our absorber and reached the design efficiency.

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OPERATING INSTRUCTIONS - V 103

for a vertical, double-acting reciprocating compressor, with two cranks, compressing gas in two single stages.

The operator must be well instructed about the function of the compressor.

A) Design dates

Medium:	natural gas
Flow rate:	37 000 Nm3/h
Suction pressure:	20.9 bar, adjustable
Discharge pressure:	46 bar
Speed:	495 rpm
Controlling system:	automatic reverse flow regulation to 50 % of design gas flow

B) Starting up of the compressor

1. Inform the central command station of our company about the start up of the compressor. Between two starts it is necessary to wait 20 minutes after the first start because during start of the motor coils are heated.

2. Open the cooling water main valve and also valves for the cooling system of the different parts of the compressor, (steel packings, cylinders, oil cooler).

3. Check the level of oil tank. If oil temperature is below 10oC it is necessary to heat up with steam.

4. Start auxiliary oil pump and check oil pressure, (minimum 2 bar).

5. Open valves in suction pipeline and in bypass pipeline. Check the suction pressure. With regard to the rate of suction pressure see point C 1.

6. Drain the condensate separators F 103 and F 104 (separator in front of the compressor and after bypass cooler).

7. Open valves in discharge pipeline.

8. Start the motor and observe the oil pressure.

9. Switch off the auxiliary oil pump and check the oil pressure once again.

10. If everything is prepared the compressor is charged by slowly closing the bypass valve and by means of the reverse flow controlling system.

C) <u>Operation of the machine</u>

1. It is very important to take care that the difference in pressure between discharge and intake is not higher than 27.4 bar.

Therefore it is necessary to adjust the discharge pressure in dependance of the suction pressure. For example: if the discharge pressure is 44 bar the intake pressure may be 16.6 bar as minimum.

The intake pressure should not be less than 8.8 bar, in this case the maximum discharge pressure is 36.2 bar. The intake pressure should not be higher than 27 bar, it is important that this maximum pressure is not reached.

2. Following points have to be checked periodically and must be written in an operating book for instance every hour:

a) intake pressure (safety valve is set a 30 bar), discharge pressure (safety valve is set at 46 bar)
b) oil pressure after cleaner
c) oil temperature after oil cooler
d) temperature of discharge
e) temperature of compressor bearings
f) temperature of motor
g) temperature of motor oil
h) temperature of cooling air to the motor
i) temperature of cooling air from the motor
k) current consumption of the motor

3. During the inspection round every two hours following points are to be checked:

a) seal packings for tightness
b) draining of separator F 103 and F 104
c) compressor for knocking, grumbling and unusual noise of the valves
d) level of the oil tank

4. Cooling water flow rate is to be adjusted not to exceed a maximum temperature of 45oC outlet.

5. The compressor is to be switched off immediately if

a)a bearing or a seal packing is overheating or if a seal packing leaks

b) lube pressureoil is less than 1.5 bar

c) if a knocking noise is suddenly heard or if the valves do not operate properly

d) a safety valve does not close after blowing down

D) Switching off the compressor

1. Switch off the motor
2. Close valves in discharge pipeline
3. Close valves in intake pipeline
4. Close cooling water main valve
5. If necessary purge compressor with nitrogen

E) General maintenance

Crankcase is filled with oil, type Mobil oil extra heavy, with a viscosity of 60 - 83 c St at 50oC temperature. Oil leakages have to be made good with the same oil type. If the compressor does not operate for a longer period the compressor must be turned by hand once a day. Before doing that the auxiliary oilpump has to be switched on.

DATA V 103

Important: The difference in pressure between intake and discharge may not be higher than 27.4 bar.

	item	Operating range	Alarm/shut down
Intake pressure	PIALLHSL	see point C 1	High: 18/10 bar low: 28/- bar
Discharge pressure	PIAHHSH	max. 44 bar	45/52 bar
Temperature of discharge	TIAH 110 TIAH 116	max. 110°C	130/-°C
Oil pressure after cleaner	PIALISL 113	2 - 3 - 4,2 bar	2/1,5 bar
Instrument air pressure	PIALSL 221	7 - 7,5 bar	4/4 bar
Oil temperature after cooler	TIALH 113	25 - 40°C	Low: 18/-°C high:50/-°C
Temperature of compressor bearing east	TIAHHSH 107	45 - 65°C	70/80°C
Temperature of compressor bearing west	TIAH 111	60 - 70°C	75/80°C
Temperature of cooling air to the motor	TIAH 101	5 - 35°C	40/-°C
Temperature of cooling air from the motor	TIAH 102	25 - 60°C	65/-°C
Temperature of motor bearing	TIAH 106	40 - 65°C	70/-°C
Temperature of motor coils	trah 104	60 - 90°C	105/-°C

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DRAWING UP A PROGRAM FOR A GENERAL OVERHAUL OF A SINGLE-TRAIN PLANT

1. During operation of our plant all technical defects and leaks are registered in a booklet. These defects do not make it necessary to turn off our plant but the next shut down of the unit all these defects must be repaired.

2. The technical department evaluates the program for the maintenance work to be done on tanks, boilers, coolers, etc. In a discussion with TÜV (technical inspection department) and the material testing department the class of inspection is determined.

The technical department is also responsible for the inspection of the machines. As a general rule, a machine which operates normally should not be opened.

Before deciding to open a machine or not, two consideration should be taken into account:

a) By measuring the efficiency it is possible to recognize a defect or wear for example on the labyrinths or on the balance drum.

b) By comparing the operation data with the data recorded at the first start up of the machine, a conclusion can be drawn about the condition of the machine.

Therefore it is very important to register all data recorded after the first start up of the machine very exactly.

The particular jobs which have to be done are ordered in groups (from 100 to 700, see enclosures).

Every work must be evaluated in regard to length of time and to the number of required workers by a foreman. Afterwards a bar chart showing the number of the necessary and disposable workers must be produced.

GROUP 100

O - 101	Heater for heating naphtha or natural gas. Open and close manhole cover. Inspection of the projecting bars of the burners.
W - 101	Nitrogen preheater Open lid for official inspection.

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GROUP 200

W - 202 II, W - 208 III, W - 210 — Superheater for high pressure steam.
Pressure check.

W - 207 — Superheater for medium pressure steam.
Pressure check.

W - 209,
W - 211 — Heater for process air.
Pressure check.

V - 202,
V - 203 — Combustion air blower, flue gas blower. Cut out the shaft cover for oil level inspection glass and for grease nipples. Inspection of the guide blade bearings.

O - 201 — Primary reformer.
Open two of the collector pipe covers, check and close.
Open manholes, inspect fireclay cover.
Clean flue gas duct.

O - 204 — Additional heating for waste gas.
Open manholes, inspect fireclay cover.

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O - 202 Additional vessel
Inspectin and cleaning of inside.
Repair combustion air heat-exchanger (no. 4 is blocking)
Inspect wall at inspection hole.
Clear lubrication pipes.

Combustion air and waste gas duct

Inspection and cleaning

R - 210 Mixing station for steam and natural gas.
Inside inspection and check natural gas baffle.

W - 215 Water preheater
Remove heat-exchanger tubes for inside inspection.

B - 208 Relief tank
Open manholes, block off, official inspection.

B - 203 Degasifier tank
Widen passage for L-206 (level controller).
Check shower (system Stork) and change T-parts.

B - 209 Instrument air tank
Inspection and cleaning of tank and level controller.

P - 207
P - 208 BFW pumps
Clean filter, P-208: change flange of valve for minimum load pipeline.

T - 203	Turbine for P-207 Repair oil leak at coupling cover. Change insulation.
B - 212	Natural gas mixing station Remove and inside inspection.
K - 201	Secondary reformer Open for changing air nozzle.
W - 201	Process gas heat exchanger Open both manhole covers. (Gasket of the hot manhole is not tight) Cleaning and inside inspection.
W - 203	BFW preheater Change pipe bundle, inside inspection. Change drain valve. Install test blades.
B - 201	Steam boiler Open and inside inspection. Pressure check (pressure check also for no. 4083 and 4162 - support system).
T - 201	Turbine for process air compressor. Inspect rotor. Repair oil leak at the compressorside coupling cover. Repair seal packing of control valve and the leak at the pipeline for the pressure-indicator of the injector; the idling-device does not function properly.

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W - 204	Condenser for T-201 Open flange and inside inspection. Repair cooling-water pipe to the condenser.
V - 201	Process air compressor Check low-pressure and high-pressure rotor. Gearbox-side high-pressure rotor bearing is leaking. Clear air-cooling of low-pressure compressor. Change cooling-water valve for 4th stage. Check non-return valve.
W - 214	Process air cooler Inside inspection, also for condensed water tank and level controller.
T - 202	Turbine for generator Repair seal box of steam entrance valve.
T - 204	Back-pressure turbine for generaor Repair seal box of steam valve.

GROUP 300

W - 301 Gas heat-exchanger

Pressure check. Repair leaky hand-gasket.

K - 301 NT- CO- converter
Official inspection, manholes to be opened in service. Change nozzle for condensate.

W - 302,
W - 303 BFW preheater
Official inspection
Repair baffle T-310

K - 302 Low temperature converter
Open manholes to change catalyst.
Official inspection.

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GROUP 400

<u>K - 401</u> Absorber
Open manholes, remove ceramic intalox and inspect inside. Install redistributors. Revision of the level controller.

<u>F - 403</u> Lye separator
Open for official inspection. Revision of the level controller.

<u>W - 401</u> Steam generator
Open for official inspection (inside revision and pressure check)

<u>W - 402</u> BFW preheater
Remove heat-exchanger. Pressure check (2 times).

<u>W - 403</u> Reboiler
Open forofficial inspection (inside and pressure check)

<u>W - 404</u> Solution air cooler
Remove distribution pipe, pressure test.

<u>W - 408</u> BFW cooler
Remove bundle (inside inspection)

<u>B - 404</u> Relief tank
Open manholes for cleaning and inspection

F - 401	Condensate separator Open manholes for cleaning and inside inspection
F - 402	Condensate separator Open manholes for cleaning and inside inspection. Change draining valve. Official inspection of level controller.
F - 406	Lye double filter Inside inspection. Grind 4-way valves. Change valve in the pipeline to the filter (valve case is corroded).
K - 402	Desorber Open manholes for inside inspection and cleaning. Repair corroded pipeline to P-405. Install PV/H-411 and PV/H-412 in CO_2 pipeline system
F - 407	Injector Control injector nozzles and valves.
W - 406	BFW preheater Change pipelines of BFW-system
T - 401	Benfield Solution turbine Seal bearings of guide-baldes. Change pipelines for greasing seals with condensate of T-401 and highpressure lye pump P-403.

GROUP 500

K - 501	Methane generator Open manholes for inside inspection
F - 501	Condensate separator Open manholes for inspection inside and inspection of level controller.
W - 501	Gas/gas heat exchanger Remove heat-exchanger for official inspection and pressure check.
W - 502	Boiler Open for cleaning and inspect inside.
W - 503, W - 504	Final gas cooler Open for cleaning and official inspection. Weld in a valve in cooling-water pipeline.

GROUP 600

T - 601 Syngas turbine
Inspection of condensation turbine rotor and of the condenser. Repair of cooling water pipe. Check start up equipment and adjust it. Change prepared oil pipelines.

V - 601 Syngas compressor
Inspection of bearings, seal-system and rotors of cases 1 - 4. Install capacity flow measuring nozzles in balance drum pipes of stage 2 and 3 (F-6006 and F-6007). Change gas cooler. Official inspection of separator F-606 (also level controller), F-601, F-602, F-603, F-605, seal oil tanks no. 4054 - 4057, level controllers 4156 and 4157, and separators 4208, 4058 and 4059.
Install valves in seal-oil pressure pipes of seal-oil pumps.
Change oil-filters and clean oil-heaters.
Change one of the oil-cooler bundles and clean the other one.

O - 701 Start-up heater
Inspect supports, pressure check.

W - 701 Waste heat boiler
Open "Brettschneider" gasket.
Official inspection, pressure check.

W - 708	BFW preheater Open "Brettschneider" gasket(seal ring is leaky) Official inspection, pressure check.
B - 701	NH3 expansion tank Open tank for cleaning and official inspection
B - 706	Mixing station Remove for inside inspection
F - 701	NH3 separator Open lids and remove pipelines to the separator Clean and inside inspection.
F - 702	NH3 separator Open lids and remove pipelines. Clean and inside inspection.
W - 703	Gas cooler Remove elbows of two of the five coolers. Pressure check these coolers.
W - 704	Gas heat-exchanger Open flanges and remove bundle. Cleaning and inside inspection.
W - 705	Freezer Remove flanges for inside inspection.

APPLICATION	CODE: Mat. No.	CODE: Internat. Code		COMPOSITION (%): C	Si	Ma	Cr	Mo	Ni	V	Ti	
(0-40 bar up to [illegible])	1,0305	St 35.8										
[illegible] pressure steam lines 40÷128 bar (from 400-525°C)	1,7335	13CrMo 44		0,10 0,18	0,15 0,35	0,40 0,70	0,70 1,00	0,40 0,50				
[illegible] pressure syngas 0-325 bar (up to 300°C)	1,0305	St 35.8		≤0,17	≤0,35	>0,40						P,S max. [illegible]
0 - 35 bar (from 300-450°C)	1,5415	15 Mo 3										
0 - 35 bar (from 450-515°C)	1,7335	13 Cr Mo 44										
[illegible] reformer tubes	-	Gx 40 Ni Cr Nb 3324	36 X Type	0,35 0,45	max. 1,5	max. 1,5	23 27					
pigtails	1,5415	15 Mo 3	Pompey France									
collector system	1,5415	15 Mo 3		0,12÷ 0,20	0,15÷ 0,35	0,50÷ 0,70		0,25÷ 0,35				P.S max. [illegible]
lines for brickwork	-	X 10 NiCrAlTi 3320	Incoloy 800									
[illegible]-reactor shell	1,7335	13 Cr Mo 44										
[illegible]dary reformer shell	1,5415	15 Mo 3										0,75 Cu
lines for brickwork		X10 NiCrAlTi 3320	Incoloy 800	0,03	0,50	0,70	21,5		34		0,6	0,30 Al
[illegible] waste recovering boiler tubes		15Mo/Inconel 600										
tube plate	1,7335	13CrMo 44	BHW 35	≤16	0,10÷ 0,50	1,0÷ 1,60	0,20÷ 0,40	0,60÷ 1,20				P.S max. 0,015
shell	1,8807	13MnNiMo 54	Type Boveiy									
shield, ferrules, lines for brickwork		X 10NiCrAlTi 3320	Incoloy 800									
[illegible]thane reactor shell	1,7335	13 CrMo 44										
[illegible] converter shell		ATMNiMoV	Type VOEST	0,15	0,33	1,40		0,47	0,66	0,12		
basket	1,4550	X10CrNiMoNb 1812	(hydrogen resist.)	≤0,10	≤1,0	≤2,0	17,0÷ 19,0		9÷ 11			>5x C Nb >8xC
[illegible] temperature converter	1,7335	13 CrMo 44										
[illegible] temperature converter												
[illegible] pressure syngas 325 bar 380÷400°C	1,7779	Altherm 50 20 CrMoV 135	Type VOEST	max. 0,21 0,17	0,30 0,50 0,15	~1,2 0,30÷	3,0÷	0,5÷		0,45÷		P.S max. [illegible]

MAIN MATERIALS USED IN SINGLE-TRAIN UNIT

		CODE			COMPOSITION %									APPLICATION
		Mat. n°.	internat. code		C	Si	Mn	Cr	Mo	Ni	V	Ti		examples
NORMAL STEEL	HEAT RESISTANT	1,0305	St. 35.8		≦0,17	≦0,35	≧0,40						P.S max. 0,05	water, gas and steam pipelines up to 300°C
		1,0425	H II		≦0,20	≦0,35	≧0,50						-"-	shell for desorber, absorber
		1,5415	15 Mo 3		0,12 0,20	0,15 0,35	0,50 0,70		0,25 0,35				P.S max. 0,04	shell for secondary reformer
		1,7335	13Cr Mo44		0,10 0,18	0,15 0,35	0,40 0,70	0,70 1,00	0,40 0,50				-"-	pipes in waste-heat system up to 550°C
		1,7380	10Cr Mo910		≦0,15	0,15 0,50	0,40 0,60	2,00 2,5	0,90 1,10					desulphur-reactor shell for waste-heat-boiler
		1,7709	21Cr MoV57		0,17 0,25	0,15 0,35	0,35 0,85	1,20 1,50	0,65 0,80		0,25 0,35			bolts up to 550°C
STEEL	HYDROGEN RESISTANT	1,7779	20Cr MoV135	N9	0,17 0,23	0,15 0,35	0,30 0,50	3,00 3,30	0,50 0,60		0,45 0,55			pipelines in ammonia synthesizer
				ATMNiMoV (T.VOEST)	0,15	0,33	1,40		0,47	0,66	0,12			shell for ammonia converter
HIGH ALLOY	STAINLESS STEEL	1,4541	X10CrNiTi189	SAS 2	≦0,10	<4,0	<2,0	17 19		9 19,5		5X %C		pipes and vessels for corrosive media lines for brickwork
			X10NiCrAlTi	Incoloy 800	0,03	0,5	0,7	21,5		34		0,6	0,75 Cu 0,30 Al	
STEEL	CASTING	1,0619	GS-C25		0,80	0,40	0,65	≤0,03						cases of naphtha pumps
		1,4027	G-X25Cr14		0,14	0,24	0,49	13,2		0,97				cases of boiling water pumps
		1,4552	G-X7CrNiNb 189		0,065	1,30	1,35	18,9		9,44			N6 0,68	cases of Benfield pumps

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ITEM	INSTRUCTOR
1. Organization of dept. ATG	Skopetz
2. Responsibilities of dept. ATG	Skopetz
3. Daily routine work	Skopetz
4. Flowsheet cooling water supply	Luger
5. Flowsheet boiler feedwater plant	Luger
6. Flowsheet waşte water neutralization	Luger
7. Cooling water return to Danube by elevation pumps	Skopetz
8. Flowsheet natural gas steam reforming	Luger
9. Maintenance to point 4, 5 and 6	Skopetz
10. Maintenance to point 10	Skopetz
11. Special materials for the primary reformer	Luger
12. Demonstration pigtail-nipping	Workshop
13. Demonstration pressure filter flushing	Luger
14. Maintenance process air compressor	Skopetz
15. Inspection process air compressor	Skopetz
16. Pneumatically regulated suction valves	Luger
17. Piston rod sealing	Skopetz
18. Guide ring controlling	Skopetz
19. Used materials in boiler feedwater plant	Luger
20. Used materials in steam reforming plant	Skopetz
21. ATG - museum	Skopetz

2. Responsibilities of dept. ATG

Dept. ATG is responsible for maintenance in the following plants:

107, 146	Old and new water station (river water and cooling water supply)
140	Chlorination station for well water (0.7 - 0.8 mg Cl/h H2O)
144	Horizontal pumps for well water
204	Air separation plant (2 units, each 1 700 Nm3/h O2), compressed air supply
204 a, b	Bottling of oxygen and compressed air
206, 209	N2 gasometers (2 000 m3, 500 m3)
207	O2 gasometer (10 000 m3)
208	Cracked ammonia (N2 + H2) holder (25 000 m3)
R. Br.	Pipe bridges
RN	Network of pipes, piping of: KOG, natural gas, heating gas, cracked gas, steam 25, 20, 7, 2 bar, compressed air, river well, hot (90oC), warm (40oC), drinking water, boiler feedwater, condensate, oxygen.

Machines, compressors and pumps in dept. urea (except standard pumps).

212	Battery (block) of bottles for high-pressure N2
202	Old gas reforming plant
220	Naphtha and Orthoxylol tanks and pump stations (tank farm)

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Pipelines for naphtha and orthoxylol

101, 211	Natural gas pressure reducing stations
110	Old boiler house (2 units, each 12 t/h steam 25 bar)
110 a, b	Contact sludge circulation reactors (flocculators)
203	Boiler feed water treatment
213	Naphtha intermediate storage facilities
214	Naphtha steam reforming plant (ICI plant)
148	Waste water neutralization

Dept. ATG has to organize all planned shut downs for these plants and also for the several machines (routine overhaul). ATG is in this way responsible for the maintenance cost in all plants also for the cost of foreign departments working in a. m. plants.

Resp. for programs, spare parts.

3. Daily routine work

Maintenance philosophy

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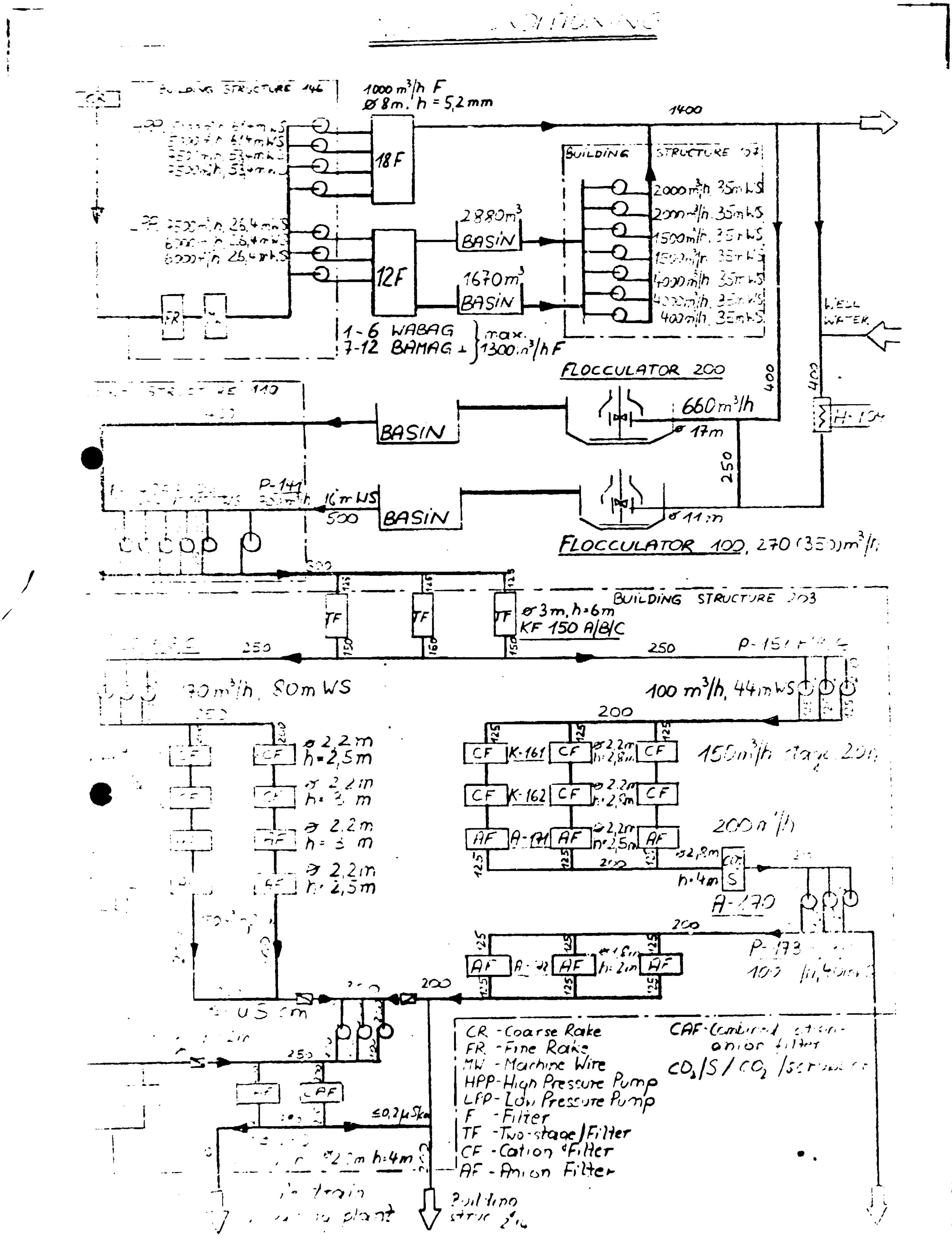
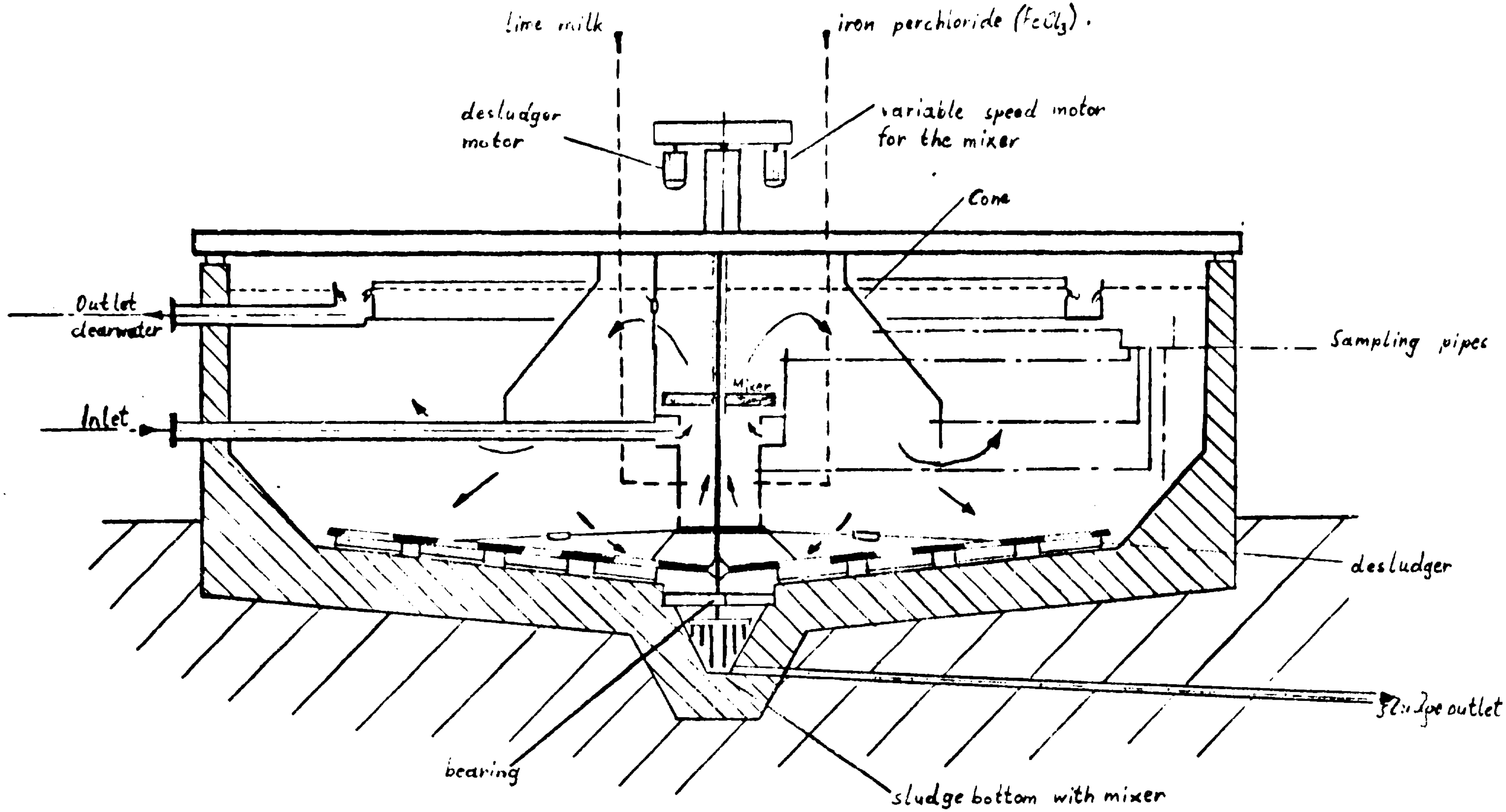
D A N U B E   W A T E R

pH	8
conductivity	263 x 10 S/cm (S=Siemens 1 S = 1A:1V = 1:Ω)
CO_2 (free)	2.0 mg/l
O_2	6.7 mg/l
alkalinity	2.55 mval/l
hardness	8.6o dH = 153.9 ppm = 3.1 mval/l
non-carbonate hardness	1.5o dH = 26.8 ppm = 0.6 mval/l
MgO	19.4 mg/l
CaO	58.8 mg/l
solid residue from evaporation (105oC)	214 mg/l
solid residue on ignition (650o)	122 mg/l
$KMnO_4$	19 mg/l (max. 30 mg/l)
Fe	0.31 mg/l
SiO_2	3.9 mg/l
HCO_3	156 mg/l
NO_2	0.08 mg/l
NO_3	14 mg/l
Cl	9 mg/l
SO_4	29 mg/l
P_2O_5	0.19 mg/l
NH_4	0.12 mg/l
Na	6.6 mg/l
K	4.0 mg/l

suspended sticks max.	12 mg/l (for short time max. 200 mg/l)
average	3 - 40 mg/l
fouling factor of waterside by tube temp. of cooling water side	≤50oC = 2 x 10
	>50oC = 4 x 10
temperature: winter 1oC summer: 20oC	temperature rise of return water: 10oC


BUILDING STRUCTURE 146
1000 m³/h F
Ø 8m, h = 5,2 mm
18 F
12 F
1400
BUILDING STRUCTURE
2880m³ BASIN
1670m³ BASIN
2000 m³/h 35mWS
1500 m³/h 35mWS
4000 m³/h 35mWS
400 m³/h 35mWS
1-6 WABAG
7-12 BAMAG
max. 1300 m³/h F
WELL WATER
FLOCCULATOR 200
660 m³/h
ø 17m
400
250
BASIN
P-141
16 m WS
500
ø 11 m
FLOCCULATOR 100, 270 (350) m³/h
BUILDING STRUCTURE 203
TF
ø 3m, h=6m
KF 150 A/B/C
250
70 m³/h, 80m WS
100 m³/h, 44m WS
200
CF
ø 2,2m
h=2,5m
h= 3 m
AF
K-161
K-162
150 m³/h
200 m³/h
S
h: 4m
A-270
P-173
CR - Coarse Rake
FR - Fine Rake
MW - Machine Wire
HPP - High Pressure Pump
LFP - Low Pressure Pump
F - Filter
TF - Two-stage Filter
CF - Cation Filter
AF - Anion Filter
CAF - Combined cation-anion filter
CAF
≤0,2µS/cm
h:4m
plant
Building structure

FLOCCULATOR



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K S U - R e a c t o r (Flocculator)

The "Contact-Sludge-Circulation Reactor" is especially used for conditioning of surface water which must be cleared of suspended matter, colouring substances, organic contaminants and carbon. Furthermore good results are attained in other fields of water treatment, especially deironing, demanganation, deacidifying, deoiling, sterilizing (degerminating), removing substances with disagreeable odour or flavour, but also algae and float lime. In the water treating process many of these effects are to be attained simultaneously.

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General technical data

Capacity:	5 - 3 000 m3/h (per unit)
turn-around time: (dwell time)	about 60 - 90 minutes
internal circulation:	3 - 5 x quantity of flow (capacity)
saving of chemicals:	30 - 40% compared to conventional plants
speed of climb-up:	approx. 3 - 5 m/h
transparence in cleaned water:	often 1.5 - 2.0 m
turbidity content in discharged water:	10 mg/l, often 3 - 5 m/h
rate of blow down:	0.5 - 1.0% of capacity
sludge content:	15 - 25 g solid matter/l (97.5 - 98.5% water)

Function

First the untreated water flows into the cylindric middle part and there it is mixed with recycled deposite products and chemicals. The rising stream is produced by a speed regulated mixer which works like a circulation pump. This mixer makes a good mixture of all components: raw water, chemicals and activated sludge. With the aid of the contact effect of the sludge the formation of flakes begins immediately and increases quickly. After having passed the mixing zone water comes into the reaction zone and changes its direction of flow. In this zone all chemical reactions happen, whereby the flakes grow and grow.

Then a part of the water comes into the ascending pipe, while the other part flows to the outer parts of the reactor. On the bottom edge of the lower cylindric part of the big cone a sharp separating zone is formed between sludge and clear water. Sludge particles sink to the bottom, clear water rises to the surface. In the outer area of the big cone the climbing speed drops and therefore even small sludge particles cannot rise. The clear, conditioned water flows into a top collecting channel (groove). By a slowly turning desludger the sunken sludge is transported into the slime pit and is then further thickened. An automatic valve removes the sludge from the reactor intervals.

Operation

The characteristic feature of the KSU reactor is the internal circulation; a quantity of 3 - 5 times of the capacity flow is circulated in the mixing and flocculent zone. In this cycle a lot of activated sludge is carried along, so that each particle of raw water is often in contact with sludge and chemicals. The particles of slime work as crystal centers on which products of precipitation settle down directly. This principle of so called "contact sludge circulation" is the real reason for the surprisingly good conditioning effect. Good working of the reactor is revealed by the sharp separating zone between muddy water and rising clear water, further on the quick sinking process of old dereacted sludge.

Total demineralization / fundamental principles

It has long been known that salts dissolved in water dissociate more or less into their components that means into ions, common salt (kitchen salt), for example, dissociates into the positive sodium ion and the negative chlorine ion. This dissociation makes water electrically conductive and so it is possible to separate cations and anions by direct current. Nearly all salts dissolved in water dissociate into cations in this way; and anions the most important of them can be put in order as in the following scheme:

cations:	anions:		
Ca	(HCO3)2	K	H
Mg	(HCO3)2		
Ca	SO4	N	
Mg	SO4		
Ca	Cl2		
Mg	Cl2		
Na	Cl	neutral salts	
Na2	SO4		
Na2	SiO3		
K	= carbonate hardness		
N	= non-carbonate hardness		
K + N = H	= total hardness		

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Not all ions are equally well absorbed or delivered by ion exchangers. A very good exchange is given between cations and hydrogen ions and between anions and hydroxyl ions. Polyvalent ions of heavy metals like iron and manganese are taken up by cations first, followed by alkaline earths like calcium and magnesium, with potassium and sodium of all. A cation exchanger loaded with these ions is regenerated by acid. In this process the cations are dislodged by the hydrogen ion of the acid. According to the law of mass action (Guldberg and Waage' s law) a surplus of acid is necessary (over and above the theoretical quantity) for finishing the regeneration. The same applies the regeneration of anion exchangers by a sodium hydroxide solution. If the ion exchanger substance is exhausted the ion most difficult to be exchanged will break through first: sodium at the cation exchanger and silicic acid at the anion exchanger.

The ions capable of being exchanged are not only on the surface of the grains of the exchange resin but also inside (interior). That means that exchanging reactions need a certain minimum time to obtain relations between quantity of water, speed of filter process and quantity of exchange resin.

Variations are possible, such as strongly acidic and slightly acidic cation exchanger or strongly basic and slightly basic anion exchanger. Slightly acidic cations exchangers can be regenerated without a surplus of acid and slightly basic anion exchangers without a surplus of sodium hydroxide (caustic soda). In a combined employment of "slight" and "strong" exchangers it is possible to further use the surplus of chemicals which is absolutely necessary for the "strong" exchangers for the regeneration of the "slight" exchangers. By this a lot of chemicals can be saved. So it is more economical.

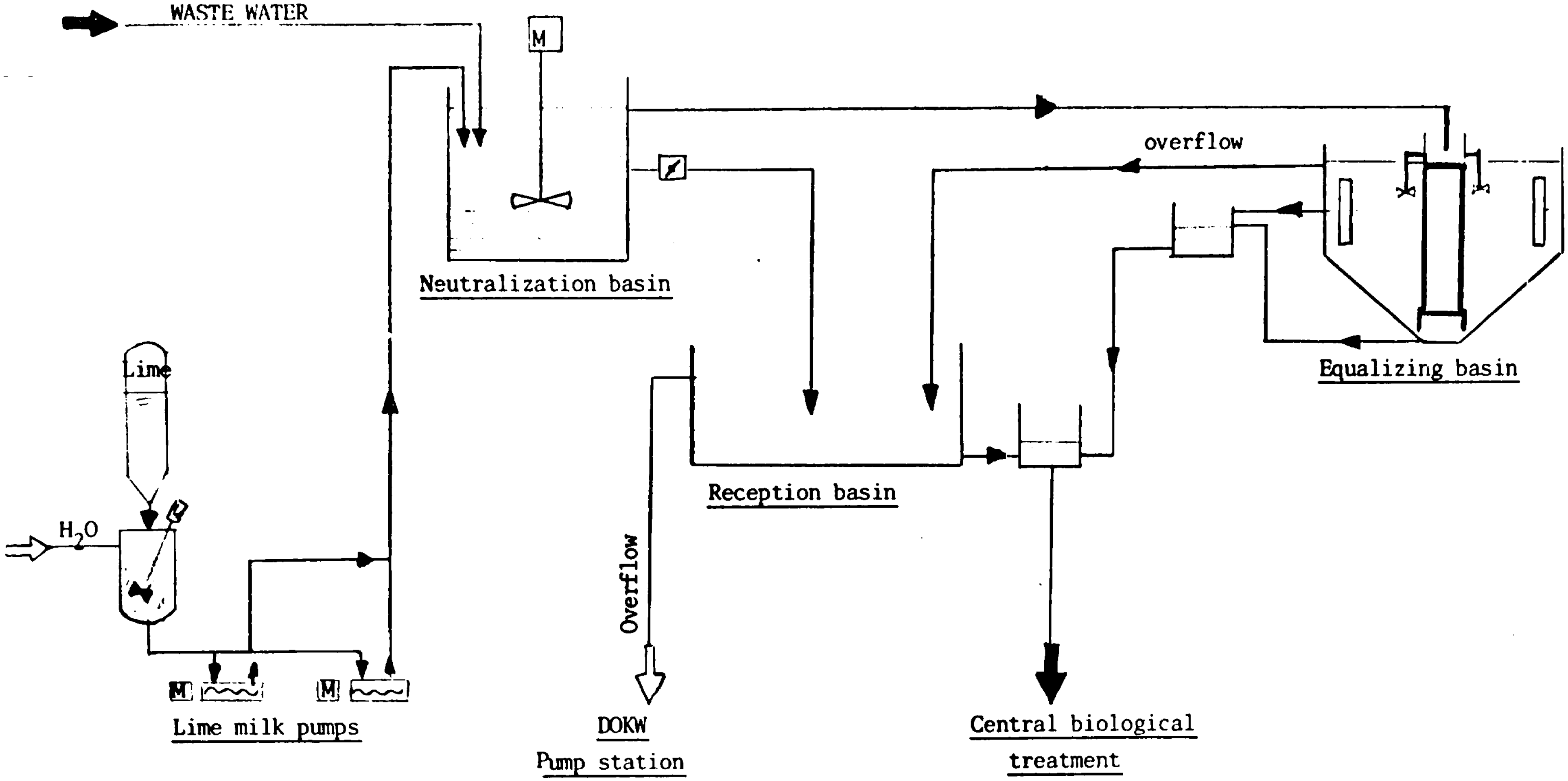
The combination of a contract sludge circulation reactor with sand filters and a total ionization (demineralization) enlarges the economical possibilities of application of total demineralization plants, especially of plants with large hourly capacities.

Total demineralization/Process

Such a plant consists of cation and anion exchangers which must be regenerated when the substance (resin) is exhausted. The regeneration process lasts for 4 - 6 hurs. During this time the plant is working with another row. So it is necessary to have at least two rows of apparatus. Further it is a great advantage to have clear water reservoirs (vessels) at the end of the plant for short time requirements of 3 - 4 hours, e. g. for small repairs or short trubles.

Mixed bed filters are situated only in the last stage; they are considered to be safety devices. The water treatment should be finished before mixed bed filters. They have only the function to catch or to kill irregularities or natural "slippage". By this working safety (reliability) of the plant is increased, and for pre-inserted filter groups cost in deminsioning of all apparatus (filters) and operating expenses can be saved because this apparatus can be fully loaded without risk.

WASTE WATER NEUTRALISATION



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Organic waste water system

In our factory there are two different waste water systems. One is the normal cooling water return system and the other one is water contaminated with organics. This contaminated water we have to collect in a special channel system with several pump stations and fan stations for the air supply in the tube systems. This system falls into a neutralization basin. There we have to neutralize the waste water to a pH in the range from 6 - 8 (the average should be about pH 7).
The pH of the waste water coming from the different departments should be minimum pH 4. After neutralization with lime milk and mixing the neutralized water runs into an equalizing basin. After equalizing the water goes to central biological treatment in Asten (near the power station Abwinden-Asten).

If the pH limits in the neutralization basin are exceeded a butterfly valve opens automatically and the waste water runs to a reception basin.

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HISTORY OF Np PRODUCTION (ATG)

Np ..... parts of N in NH3 (14 Mol N + 3 Mol H = 17 Mol NH3)

Spring 1940:	start on raising the ground level about 2 - 4 m.
Autumn 1942:	Start of production on basic KOG. (1 unit for desulphuration, 3 units for gas dividing and 3 - for CO conversion).
1944:	Output 55 000 t Np/a
1944/1945:	about 800 bombs from allied airforces exploded in Chemie Linz area and plants
May 1945:	-
July 1946:	No production as neither KOG nor energy were available.
1948:	1944 output level reached again
↓	production increase
1965:	to 237 000 t Np/a or 718 t/d max. (3 units for desulphation, 6 for gas dividing and 7 for CO conversion)
1966:	start up of naphtha steam reforming plant
↓	increase
1974:	to about 320 000 t Np/a
1979:	to about 520 000 t Np/a
1980:	to about 480 000 t Np/a

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NAPHTHA STEAM REFORMING PLANT (ICI PROCESS)

General

Engineered by Humphreys & Glasgow, London, 1964 - 1966; erected by ourselves. Laying out: 300 t Np/d (365 t NH3/d) at a pressure of 28 bar (max. 31 bar). Beyond the ICI licence (our risk) we increased the working pressure (inlet prim. reformer) to 38 bar and the daily output to 420 t Np (510 t/d NH3). We had bought machines, apparatus and pipes qualified for higher pressure.

Feedstock

1966 (start up) - 1976 naphtha (strait run benzines); since 1976 - natural gs.

Maintenance

	hours	material cost (mill. AS)
1974	21 000	1.3
1975 general overhaul	56 000	7.4
1976	24 000	1.6
1977 general overhaul	46 000	4.2
1978	16 000	1.6
1979	21 000	0.8
1980	49 000	0.9
1981	16 000	0.1

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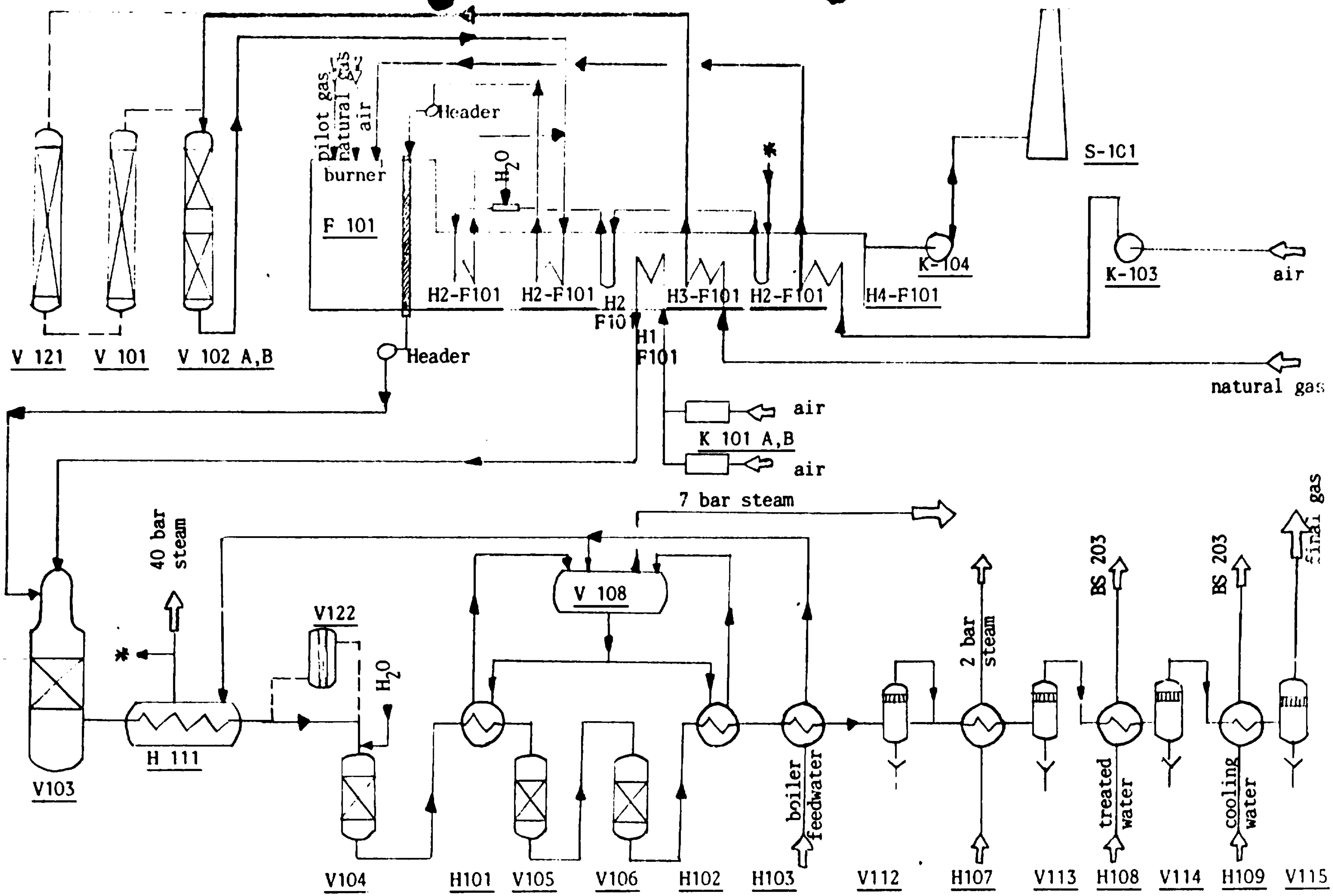
On stream days:

1974		363
1975	gen. overhaul	324
1976		366
1977	gen. overhaul	325
1978	intended 3shut down during Single-Train shut down for welding-piping connections between both plants.	362
1979		365

NATURAL GAS STEAM REFORMING



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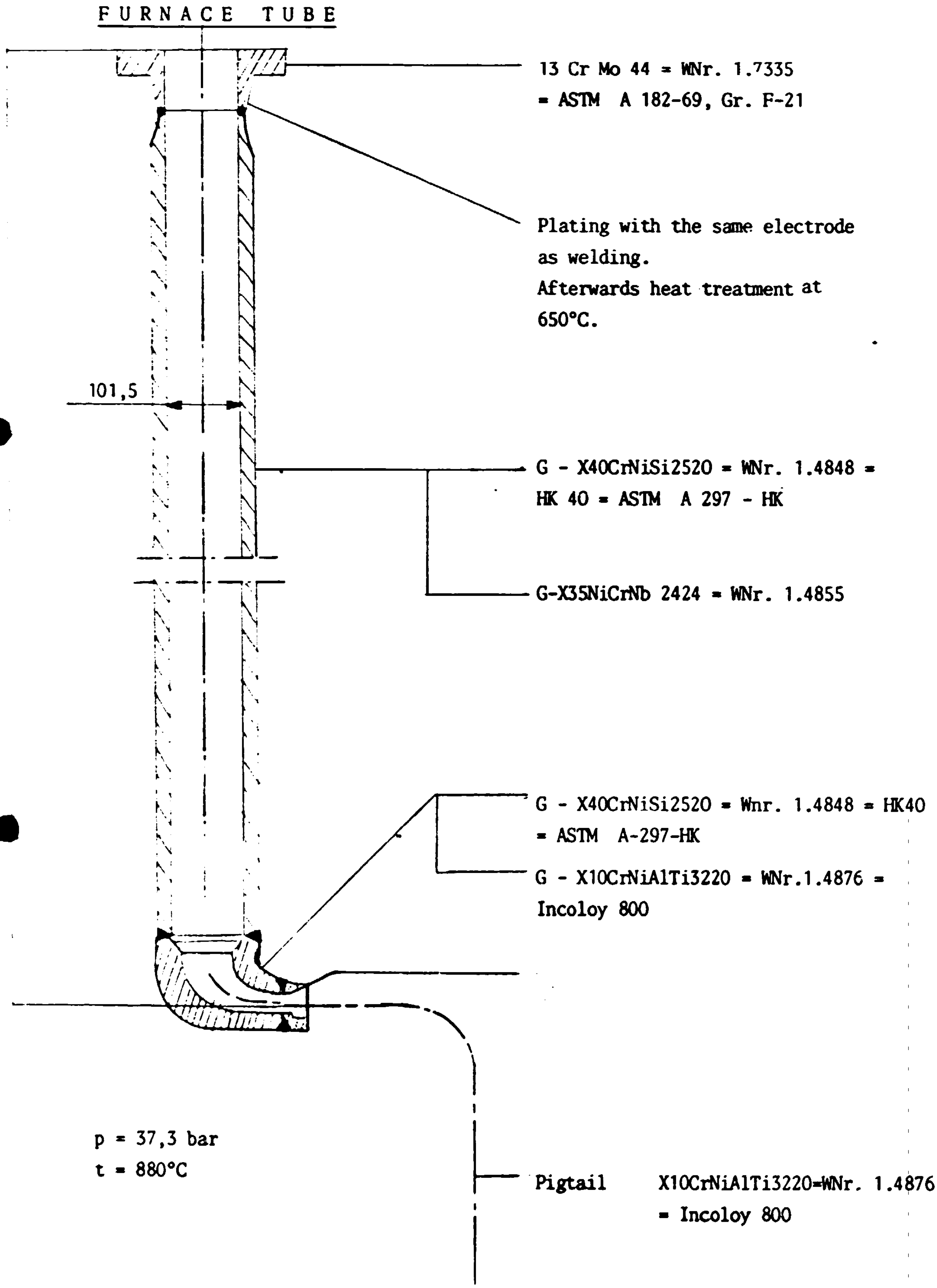
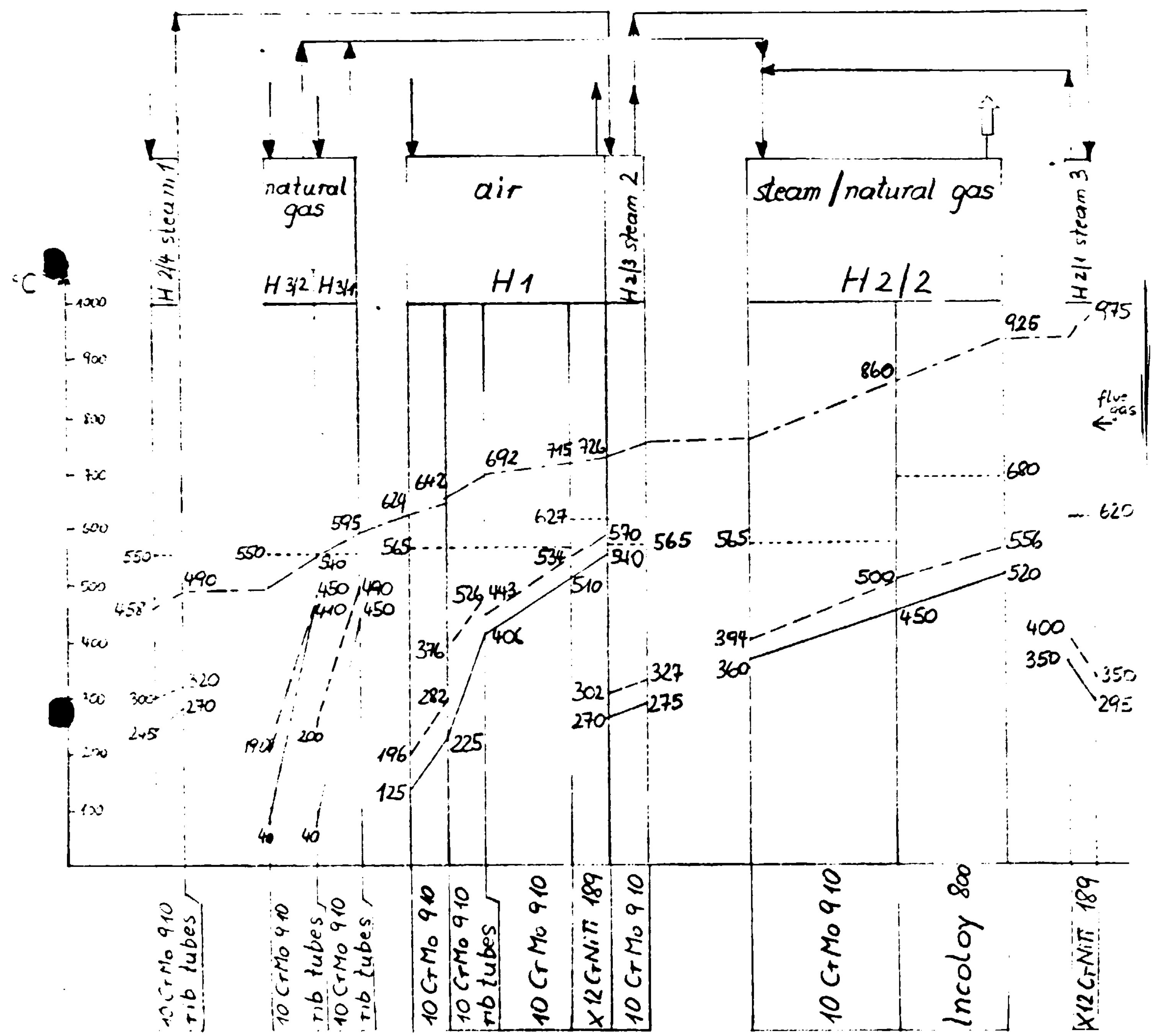
F - 101	Primary reformer
H 1 - F 101	Process air heater
H 2 - F 101	Heater for steam
H 3 - F 101	Natural gas heater
H 4 - F 101	Combustion air heater
K - 101 A/B	Air compressor
K - 103	Combustion air fan
K - 104	Flue gas fan
S - 101	Stack
V - 101*	Primary desulphurizer
V - 102 A/B	Secondary desulphurizer
V - 103	Secondary reformer
V - 104	Primary CO converter
V - 105	Sulphur catch vessel
V - 106	Secondary CO converter
V - 108	Steam drum
V - 112, 113, 114, 115	Gas separator
V - 121*	Carbon catch vessel
V - 122*	Potassium catch vessel
H - 101	Waste heat boiler
H - 102	Waste heat boiler
H - 103	Boiler feedwater
H - 107	2 bar steamboiler
H - 108	Treated water cooler
H - 109	Raw water cooler
H - 111	Waste heat boiler

*) Only with naphtha steam reforming in progress.



FURNACE TUBE
13 Cr Mo 44 = WNr. 1.7335
= ASTM A 182-69, Gr. F-21
Plating with the same electrode as welding.
Afterwards heat treatment at 650°C.
101,5
G - X40CrNiSi2520 = WNr. 1.4848 =
HK 40 = ASTM A 297 - HK
G-X35NiCrNb 2424 = WNr. 1.4855
G - X40CrNiSi2520 = Wnr. 1.4848 = HK40
= ASTM A-297-HK
G - X10CrNiAlTi3220 = WNr.1.4876 =
Incoloy 800
p = 37,3 bar
t = 880°C
Pigtail X10CrNiAlTi3220=WNr. 1.4876
= Incoloy 800

CONVECTION ZONE



——— product temperature

– – – – tube temperature

—·—·— flue gas temperature

· · · · · max. allowable tube temperature

1. Furnace tube

a. G - X 40 CrNiSi 2520 = W.Nr. 1.4848 = ASTM A - 297 - HK

Approximate analysis:	C~0.4%, Cr~25%, Ni~25%, Si~2.5%
Melting point:	1 400oC
Working temperature:	800 - 950oC
Weldability:	good
Thermal expansion between 20oC and 1000oC:	10.0 10^{-6} m/moC
Heat conductivity (20oC):	0,147 J/cm soC
Tensile strength (20oC):	440 N/mm2
Yield point (20oC):	245 N/mm2

b. G - X 35 NiNb 2424 = W.Nr. 1.4855

Approximate analysis:	C~0, 35%, Ni~24%, Cr~24%
Melting point:	1 350oC
Working temperature:	850 - 1 000oC
Weldability:	good
Thermal expansion between 20oC and 1000oC:	19.6 . 10^{-6} m/moC
Heat conductivity (20oC):	(0.148 J/cm soC)
Tensile strength (20oC):	440 N/mm2
Yield point:	245 N/mm2

c. X 10 CrNiAlTi 3220 = W.Nr. 1.4876 = Incoloy 800

Approximate analysis:	C~0, 1%, Cr~32%, Ni~20%, Al≤0.6 %, Ti≤0.6%
Melting point:	1 350oC
Resistant in air up to:	1 150oC
Weldability:	good
Thermal expansion between 20oC and 1000oC:	18.7 . 10^{-6} m/moC
Heat conductivity (20oC):	0.097 J/cm s oC
Tensile strength (20oC):	540 N/mm2
Yield point (20oC):	245 N/mm2

d. 13 CrMo 44 = W.Nr. 1.7335 = ASTM A 182-69, Gr. F-12

Approximate analysis:	C~0, 13%, Cr~1%, Mo~o.4%
Working temperature:	max. 530oC
Tensile strength (20oC):	440 N/mm2
Yield point (20oC):	275 N/mm2

2. **Convection zone**

a. 10 CrMo 9 10 = W.Nr. 1.7380 = ASTM A 199-Gr. T22

Approximate analysis:	C~0, 1%, Cr~2%, Mo~1%
Working temperature:	max. 530oC
Tensile strength (20oC):	440 N/mm2
Yield point (20oC):	265 N/mm2

b. X 12 CrNiTi 18 9 = W.Nr. 1.48878 = Austenitic steel CrNi 150 : 17/4 N 634 (H32)

Approximate analysis: C~0.12%, Cr~18%, Ni~9%, Ti~4 x C
Resistant in air up to: 800oC
Weldability: good
Thermal expansion between
20oC and 1000oC: 19.0 . 10^{-6} m/moC
Heat conductivity (20oC): 0,147 J/cm soC
Tensile strength (20oC): 490 N/mm2
Yield point (20oC): 245 N/mm2

c. X 10CrNiAlTi 3220 = W.Nr. 1.48876 = Incoloy 800

see 1. c.

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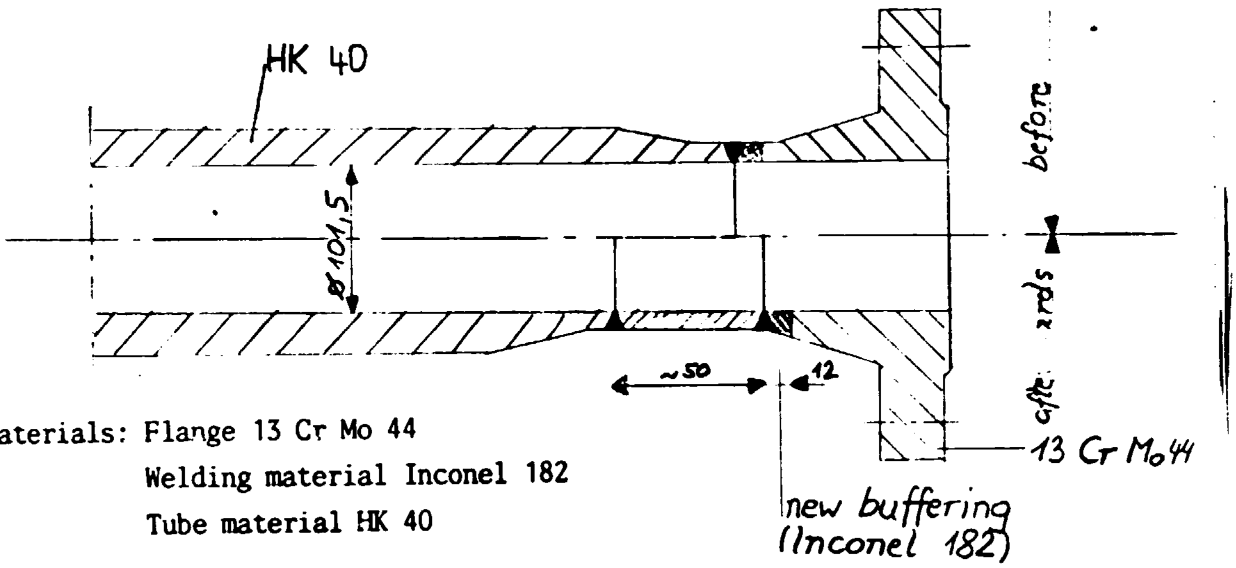
Welding procedure for furnace tubes after stress corrision:



Materials: Flange 13 Cr Mo 44
Welding material Inconel 182
Tube material HK 40

1. Cut the flange
2. Turn the flange for buffering
3. New buffering (material: Inconel 182), minimum 12 mm
4. Buffering turn to wall thickness.
   The front is to cut under 90oC.
5. x-ray test - quality is IIW-black
6. Heat the flange for half an hour at 700oC - cooling to 300oC
   in the oven, rest in air.
7. Turn the weld phase
8. Dye penetrant test of the buffering
9. Dye penetrant test of the tube end
10. Cut the failers and turn the weld phase

11. Dye penetrant test this weld phase
12. Weld the flange; pay attention to the length tolerance.
    Welding: ground Inconel 182, rest with Boehler Fox NiCr70Nb.
    By heating to 70oC avoid condensate rise.
13. Dye penetrant test the ground of welding.
14. Dye penetrant test the top layer.
15. x-ray test quality IIW-black
16. Be careful during transport - tubes are brittle!

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BLANKING-OFF REFORMER TUBES DURING PLANT OPERATION

B. Estruch

1. Introduction

When a reformer tube bursts during service the loss of gas through the leak is not necessarily intolerable but the leaking gas ingnites inside the furnace and causes overheating of the surroundings. To prevent damage to the refractory and to the neighbouring tubes, it is necessary to isolate the failed tube.

To achieve this either the design must make provision for shutting off any individual tube or, if simply welded up connections are used, the whole unit must be shut down and cooled so that the failed tube can be cut out and replaced, or the connections plugged by welding.

Because the outlet pigtails usually operate in the region 700 - 800oC, and no valves are known that could be fitted in each pig-tail, and because at any rate the expense and complication of fitting them in the design would be considerable, an all welded design is normally adopted. Initially, when an overheated tube leaked the furnace had to be taken off line losing some 36 hours' production. This represented a serious loss of output. Apart from that, in reformer plants built for the production of town gas the manufacturing authority is under legal compulsion to maintain a minimum gas pressure, and it could hardly afford to shut down a furnace even for only 30 hours should a tube fail during a period of peak demand. Consideration was therefore given to methods of blanking-off leaking tubes which would not necessitate shutting the plant down.

2. Background

It has been standard practice for many years to squeeze mild steel pipes on gas and water service when it had become necessary to isolate a line and a number of devices are commercially available for this purpose. However the application of gross plastic deformation to pressure equipment containing hot inflammable gases had not been considered. The commercially available apparatus for low temperature service is hydraulically operated, which is an advantage, but the frame has to be dismantled and then reassembled on to the pipe to be squeezed. This would have been perhaps acceptable for inlet pigtails where the temperature is around 400oC, but the manipulation involved would not be acceptable in the proximity of the hot outlet pigtails (700 - 800oC). For that reason a G-clamp squeezer was designed so that the unit could be placed onto the pigtail where it runs horizontally adjacent to the reformer tube (Clark and Elmes Paper 2, Fig. 2) and all that was required in the way of preparation was to remove the lagging on this selection.

3. G-Clamp Squeezer

Details of the squeezer are given in the drawing in Fig. 1 and the photograph of Fig. 2. It is driven by a short 6 ton hydraulic ram, manufactured by Epco Flexi-Force.

The main advantages of this design are:

(1) The G shape of the frame reduces manipulation near the pipes before squeezing to hanging the device onto a horizontal part of the pigtail.

(2) It is connected to the pump by means of a pressure hose of convenient length so that the operator is at a safe distance while the tube is being squeezed. It is relevant to mention here that, in the event of a pigtail cracking while being squeezed, Billingham experience has shown that the fire that results from a pigtail failure does not cause significant damage.

(3) Should any accident happen to the hydraulic ram, to the hose or to the pump the quantity of oil involved is very small (1 - 2 pints).

(4) After squeezing the jaws can be fastened together by means of screws to form a permanent clamp to prevent the internal pressure opening up the squeezed pipe. The G clamp and hydraulic ram can then be removed by simply letting the jaws slide off along the guides shown in the drawing.

(5) The jaws are kept in position by means of ball catches while the clamp is being hund and while pressure is being applied.

(6) Two lateral sheet metal pieces locate the clamp jaws on the pipe and are crushed away as the squeezing operation is in progress.

4. Laboratory Tests

Although from the above considerations it appeared that blanking-off reformer tubes by flattening the inlet and outlet pigtails could be achieved with reasonable safety it was decided to carry out some preliminary tests on a laboratory scale.

In order to simulate plant conditions a test rig was arranged in which a length of pipe could be electrically heated by making it an integral part of a circuit connected to a low voltage high current source. One of the ends of the tube was blanked-off and the other connected to a 275 p.s.i.g. steam line. Provision for measuring the steam pressure and for measuring and controlling the temperature during the tests were made. Samples of both Incoloy and Cr-Mo pipe were tested. The clamp itself was tested under a 7 ton load without it showing any permanent set.

4.1 Incoloy Pigtails

Two samples of extruded Incoloy DS tubing, 1 11/32 in. o. d. x 8 s. w. g. (as used for the fabrication of the outlet pigtails) were used for the trials. One sample was ex-stored but was aged for 72 hours at 800oC in order to bring it into a condition nearer to that of the pipes after service. The second sample was cut from an actual pigtail which had failed due to the presence of manufacturing defects after a few months in service.

These samples were heated to 800oC before squeezing. During the first test the temperature dropped quite considerably as the jaws touched the tube, but by insulating the ends of the pipe the temperature drop was eventually reduced to about only 20oC.

In all, eight trials were performed. The results were completely satisfactory except in one case, when a number of small cracks developed on the outside of the pipe but no leak occurred. This cracking was not thought to be significant because the trial was done on a part of the pipe which had been overheated to nearly melting point during the initial attempts to adjust the temperature. Figure 3 shows the general appearance of the tube and Figure 4 a cross-section through one of the flattered parts.

4.2 Cr-Mo Pigtails

The tests were done at 400oC on a length of 1% Cr-Mo steel pipe 13/16 in o. d. x 5/32 in. wall as used for the inlet pigtails. At this temperature the tube was too strong for the squeezer and a perfect flattening could not be achieved. In order to increase the stress on the pipe the width of the jaw faces of the clamp was reduced from 1/2 in. to 1/8 in. but then the ductility of the material was insufficient and the tube wall sheared. It was found possible to avoid this by carrying out the operation in two stages. In the first a set of jaws with slightly curved faces (1/2 in. width) was used. This spread the deformation over a large area but still left a gap between the two wall faces. A second pair of jaws with faces 1/8 in. wide and semi-circular cross section was used to close the gap. To achieve this the load had to be increased to 8.5 tons. The clamp withstood this overload well. Figures 5 and 6 show the results of the tests.

During the tests it was found that the original jaws in 18/8/Ti were too soft and yielded appreciably during operation. This was prevented by protecting the jaw faces with welded inserts of heat treated FV520(B) steel whose yield strength is about three times higher than that of 18/8/Ti steel.

5. Plant Experience

The pigtail squeezer has been used successfully on several occasions to isolate leaking reformer tubes. Squeezing the inlet pigtails has proved to be as easy in the plant as it was in the preliminary trials.

On the other hand with pigtails trouble has experienced on the three or four occasions owing to cracks forming during the operation. It appears that the difficulties are due to a combination of the following factors:

(1) Embrittlement during service. It is known that the ductility of Incoloy DS decreases with time due to an age hardening process. The use of Incoloy 800 which is now readily available and reputed to be less prone to embrittlement during service will probably improve matters.

(2) Decrease in temperature. As soon as the flow or hot gas through the pigtail is restricted the metal temperature begins to fall and so does its ductility. The more quickly the operation is completed the less likely is trouble to occure. The possibility of locally increasing the temperature of the outlet pigtail prior to squeezing is also being considered.

(3) The occasional presence of score marks on the surface and stringers of inclusions inside the pipe wall which facilities the initiation and propagation of cracks.

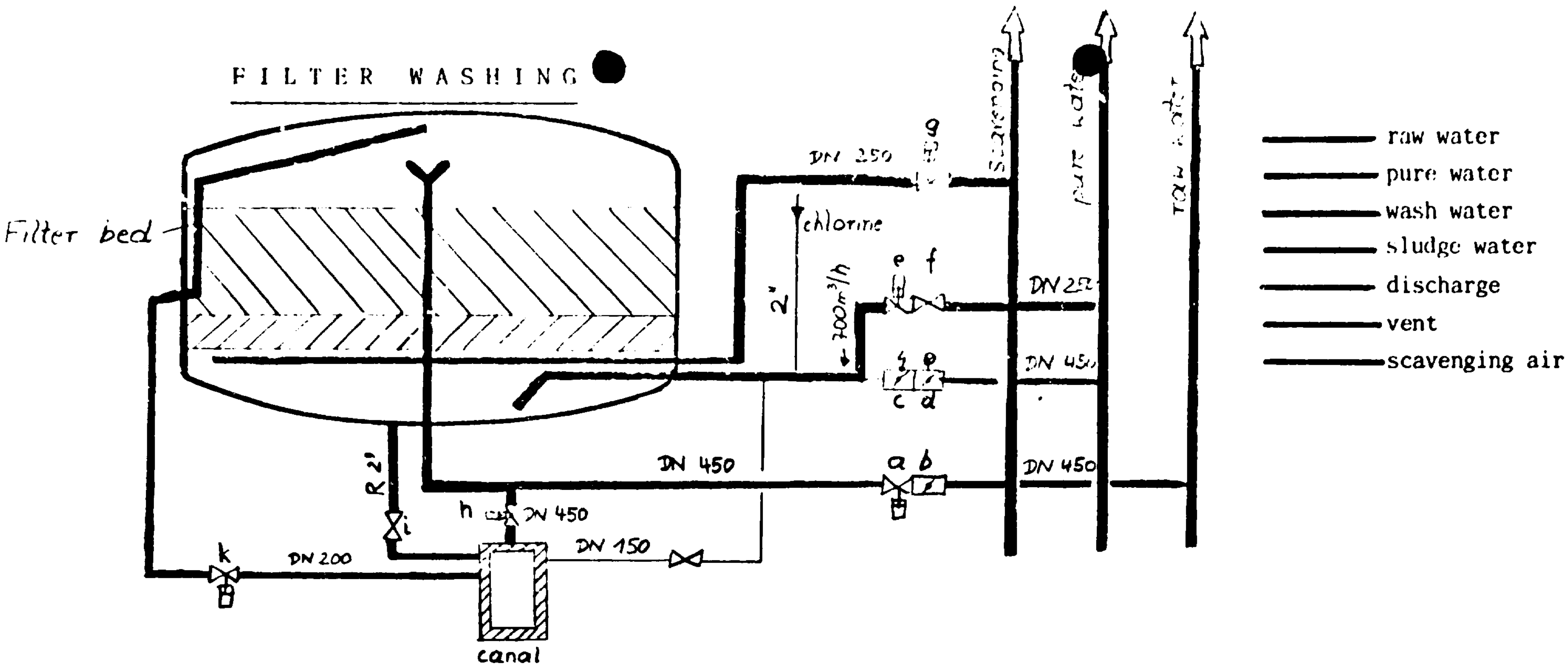
In spite of these occasional difficulties it always has been possible to blank-off the failed reformer tube. Even after cracks have appeared in the pigtail its flattening has been achieved at a second attempt.

The use of screwed jaws to maintain the pitail gas tight has proved to be necessary. Whenever the jaws have been removed the leakage of gas from the reformer tube has been seen to increase gradually becoming excessive after some time. A second application of the squeezer and permanent clamping of the pigtail has been sufficient to reduce the leakage to a negligible amount.

Conclusion

Blanking-off failed reformer tubes without having to shut the plant down, by squeezing the inlet and outlet pigtails at a temperature and under pressure, has been a complete success. So far no untoward incidents have occurred; provided adequate care is taken, the isolation of the failed tube can be achieved without danger to the operating personnel or to the plant.

FILTER WASHING



Filter:

Ø = 8 000 mm
h = 5 200 mm
v = 240 m³
q = 1 000 m³/h H_2O
p = 6 bar gauge

		open	closed
1. discharge	1 minute	i, k	a, b, c, d, e, f, g, h,
2. air	2 minutes	g, k	a, b, c, d, e, f, h, i,
3. air + water	11 minutes	e, f, g, h, k,	a, b, c, d, i
4. air + water + chlorine	4 minutes	e, f, g, h, k, +chlor.	a, b, c, d, i
5. water	3 minutes	e, f, h, k,	a, b, c, d, g, i,
6. fill up with water	4 minutes	e, f, k,	a, b, c, d, g, h, i,
	25 minutes		
to filter		a, b, c, d	e, f, h, h, i, k

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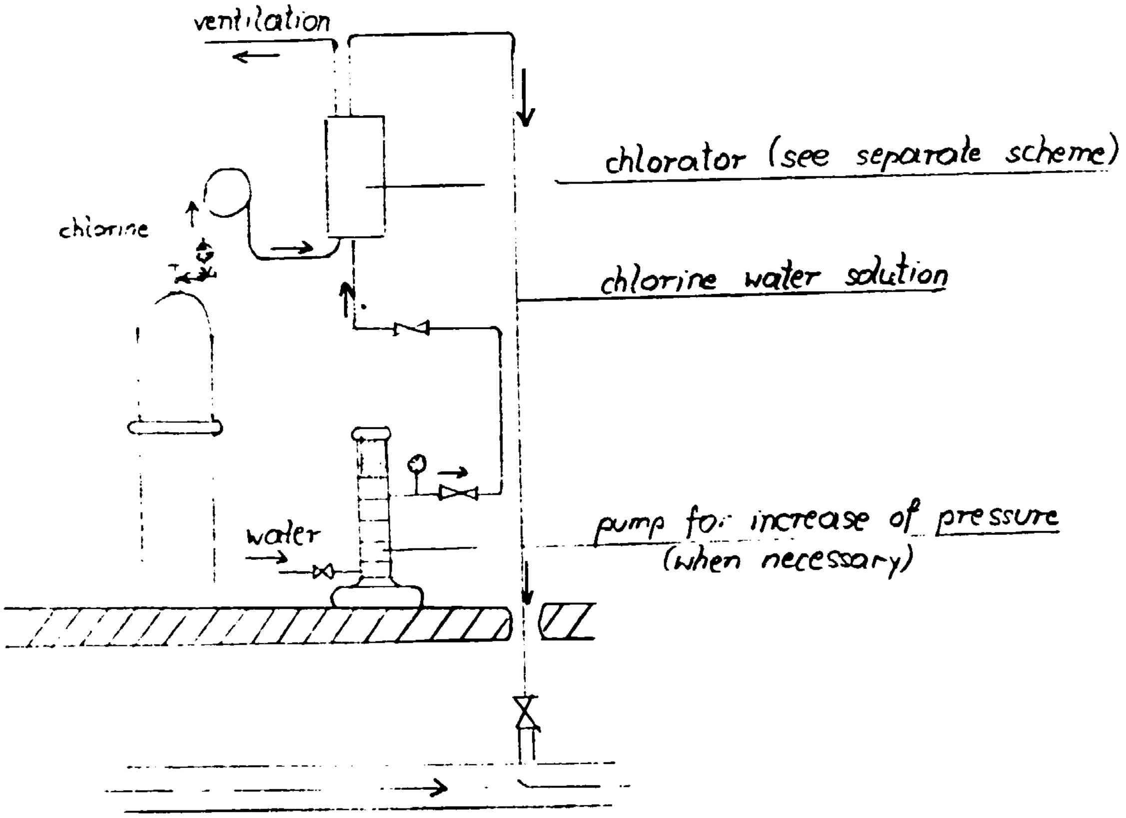
CHLORINATION



1	Compensation hole
2	Vacuum regulating valve
3	Chlorine / water solution
4	Injector
5	Water
6, 7	Adjustable V-nozzle
8	Volumenometer
9	Chlorine inlet
10	Chlorine gas reducing valve
11	Ventilation

C H L O R I N A T I O N

The injector forms a vacuum for intaking chlorine gas and mixing with water. The ball and the membrane prevent a flow back of the water into the chlorine installation when the solution outlet is closed or stopped up. For the injector to function well, it is necessary that the pressure ahead of the chlorine inlet is very high against the back pressure.

The chlorine gas comes at pressure to the chlorine pressure reducing valve. There the pressure will be reduced below the atmospheric pressure because this valve opens only when the injector forms a vacuum. If gas comes into the valve without vacuum conditions, the membrane will lift and the gas escapes through the vent pipe.
The chlorine flows from the pressure reducing valve through a volumenometer to an adjustable V-nozzle which regulates the chlorine gas capacity. After that is situated a vacuum regulating valve for building a suitable vacuum is set.

When the chlorine supply is empty or shut off the vacuum regulateing valve closes. If the throttles effect is not enough, the diaphragm will take off by the vacuum and air will enter, satiating the vacuum.

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Inspection of machinery in stage 2 and 3 - compressor east

Steps

1. Measurement of guide rings at all of the 4 cylinders.

2. Cleaning of cooling chambers of all cylinders.

3. T.inspect the position of piston rod with frame level (at upper and bottom dead center). The crosshead must be pressed on the running surface.

4. Remove piston and piston rod. To inspect or to flush (to level) the surface in the mainstop.

5. Remove bush, inspecting by TMP and refit. Measurement over cross at upper and bottom dead center, inspection with frame level. Inspection must be done with valves fitted.

6. Measurement of crosshead clearance.

7. Remove bolt of crosshead. Inspection of state of fit.

8. Remove crosshead and inspect in mainshop. (T flush the furnace).

9. Remove balancing weight.

10. Remove side rod.

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11. Measurement of breathing (swelling) of crankshaft.

12. Measurement of clearance of connecting rod bearing (big-end bearing). Measurement of 2 Ø (crank pin stud crank eye).

13. If modification of clearance is necessary, bolts must be fitted according to settled (defined) extension.

14. Both bearing bushes (pillows) must be fixed in the casing!

15. Points 3 - 13 apply equally to both stages.

16. After measuring sweiling in both stages, remove main bearings 2, 3, 4 and 5.

17. Removing main bearing
    a. Measurement of clearane
    b. Notice length of bolts in fixed state
    c. Notice length of bolts in loosened (unscrewed) state
    d. Remove pillows. The crankshaft must be lifted by hydraulic tool half the clearance
    e. Inspection of pillows by TMP
    f. Inspection of bearing necks (journals) by TMP

18. Replace main bearings.

19. At both stages: as for point 11.

20. Measurement of guideway of crosshead (Ø and II) of both stages.

21. Measurement of cylinder.

22. Replace side rods.

23. Replace crosshead.

24. Replace air packing, oil packing and piston (without rings!). Measurement of state of piston (clearance between piston and bush). Distance on the side on which the crosshead slides.
1.7 - 1.8 mm on the second stage and
1.4 - 1.5 mm at the third stage from the piston.

25. Testing the state of piston rod with frame level.

26. Finish assembling; measurement of dead space.

27 Cleaning: air filter, oil filter, oil tub (tank), steam traps, nerve, oil fitting. Tightness test of air coolers.

28. Test run

29. Inspection by TMP
   a. Screws and threads
   b. Crosshead
   c. Pillows
   d Bearing necks (journals)
   e. All antifatigue shafts of screws
   f. Shoulder of bushes
   g. Ribs of cylinder covers (tops)
   h. Shoulder of cylinders
      (connection between cylinder and casing)

Absorption Safety Loop in LINDE's air separation plant

From main condenser liquid oxygen comes to a pump which delivers it alternatively to one of two absorption vessels filled with gel. Then liquid oxygen flows back to the main condenser. By this liquid O2 is permanently in circulation through an absorption apparatus. It holds back (absorbs) 98% of acetylene (propene). All hydrocarbons not absorbed, like ethene, propane and so on enrich somewhat in the fluid.

By the absorption safety loop 1% of O2 production andby evaporation of this rate the remaining hydrocarbons are removed from the separation column (main condenser) for the most part.

The absorption vessel has a service life of 8 days. After this time the filling must be regenerated and the circulation passes through the other vessel. The content of acetylene in the main condenser is limited to 0.1 ppm. Analysis is carried out daily. For safety reasons hot nitrogen (at a pressure of 5 bar) is used as the regeneration medium.

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BOILER FEED WATER TREATMENT	LIST OF MATERIALS
Parts of plant	Materials
Sand filters with fittings and piping	Carbon steel ASTM A 283-C, with internal painting tubes: A 53-A valves: grey iron A126-class B
Ion exchangers with fittings and piping	C-steel: RST.37.2., internal rubbercoated or stainless steel vessels: C-steel A264,grade 6 367 clad. tube: A 43-A, austenitic CrNi steel valves: A126 - class B austenitic CrNi castings
Pumps in the area of ion ex-changers	A126, class B, internal rubber coated or stainless steel, AISI 316 B

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H_2SO_4 (76%) dosing pumps with f. and pipes	PVC Teflon
Na(OH) (50%) dosing pumps with fittings and pipes	PVC
$FeCl_3$ dosing pum	PVC
Flocculator	Carbon steel, normal steel with painting.

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STEAM REFORMING PLANT	LIST OF MATERIALS
Parts of plant	Materials
Furnace tube	G-X 35NiCrNb 2424, no. 4855 G-X 40CrNiSi 2520, no. 4848 HK 40, ASTM A-297, 25 Cr/20Ni
Outlet header	Centrifugal and static castings 27 Ni/18 Cr Wrought fittings: Incoloy Alloy 800
Outlet pigtails	Incoloy 800, no. 4876 Incoloy Alloy 800
V 103 - secondary reformer	shell: ASTM A 105 GII (P1), A 212 Gr. B flange: ASTM A 515-60 bolts: ASTM A 320 grade L7, A 193, Gr. B 16
H 111 - waste heat boiler	shell: A 105 Gr. I (P1) tubes: A 335 Gr. P11 flange: A 387 Gr. B P 4
V 104 - primary converter	shell: A 204 Gr. B, ASTM A 335 Gr. P1 flange: A 204 Gr. A
HH 101 - waste heat boiler	shell: ASTM A 515 - 60 tubes: ASTM A 106 Gr. B

STEAM REFORMING PLANT	LIST OF MATERIALS
Apparatus in convection zone	Materials
Heater for steam H2/1 F101	austenitic steel CrNi ISO: 17/4 N634 (H 32) ASTM A 199 Gr. T 22 (P5), A 335-P22
Heater for steam H2/4F101 Heater for steam H2/2F101 and natural gas	ASTM A 199 Gr. T22 (P5) A 335 - P22 ASTM A 199 Gr. T22 (P5) A 335 - P22 austenitic steel CrNi, ISO 17/4 N634, Incoloy 800
Process air heater H1F 101 natural gas heater H3/2F 101	ASTM A 199 Gr. T22 (P5), A 335 -P22, austenitic CrNi steel, ISO: 17/4 N634 (H 32) ASTM A 199, Gr. T 22 (P5) A 335-P22

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STEAM REFORMING PLANT	LIST OF MATERIALS
Apparatus	Materials
V 105 sulphur catch vessel	shell: ASTM A 212, Gr. B A 105 Gr. II P1 flange: ASTM A 105, Gr. I bolts: ASTM A 194, Gr. 4
V 106 secondary CO converter	shell: ASTM A 515, Gr. B, A 105 Gr. II P1 flange: ASTM A 105 - I bolts: ASTM A 194, Gr. 4
H 102 waste heat boiler III	shell: ASTM A 515, Gr. 60 tubes: ASTM A 210, Gr. A-1
H 103 boiler feedwater	shell: ASTM A 515, Gr. 60 tubes: ISO: R683 T 13/23 a ASTM A 240, Gr. TP 316 (P8)
V 112, V 113, V 114, V 115 gas separator	shell: ASTM A 105, Gr. I P1 demister: ASTM A 240, Gr. TP 316 (P8)

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R E C Y C L I N G

Increasing density of population, the formation of overcrowded regions, growing industries with expanding production and finally welfare of each people lead to an enormous burden on environment. The disposal of growing amounts of waste from industry, traffic and homes has become a worldwide problem which concerns each of us.

Wastes coming from industry, business and households are classified by use into cooling water, process water and excremental water. All these burden in various manners the bodies of the water which they are discharged into: rivers, lakes, the sea and so on. Beyond a certain point the natural force of self-purification is not sufficient, as is shown by many examples.

Hence, industries and public administration spend a lot of money on purifying waste waters. Austrian industry has spent 10 billion Austrian Shillings on purifying water since 1970. That is 41 percent of the whole environmental expenses. To keep the quality of water in good condition or to improve the quality of it, many projects involving sewage drains, purification plants and control systems are realized. Chemie Linz AG now spends 300 million Shillings for environmental purposes. 108 million Shillings are related to purifying water.

COOLING WATER

The water supply to Chemie Linz AG in industrial plants in Linz and Enns is taken entirely from the Danube, not from ground water.

In this connection we have to emphasize that most water in our plants is cooling water (about 95 %). This predominating part of our water input is given back to the river as clean water which is a little warmed up by the coolers in our plants. But the warming up of our cooling water is insignificant because waste heat is used with priority in our plants. The warming up of the Danube by our cooling water is only 0.05 to 0.1 %. The extent of warming up depends on the water flow of the Danube which varies between certain limits. The legal limit in Austria for warming up the Danube is 3 oC.

ANORGANIC PROCESS WATERS

Only a small part of our industrial water given back to the Danube is polluted. Where it is possible all polluted waters are purified and neutralized at the origin of their formation. In our plants there are more than 100 separators and neutralization units.

From the view of energy, where it is possible, process and washing water is recycled. In doing so two profits are obtained: first, far ranging purification of waste water, and secondly, the production of valuable raw materials.

In this field Chemie Linz AG developed some internationally known recycling processes, for example the production of AlF_3 from fluoride-bearing waste water from phosphate fertilizer production. AlF_3 is a desired raw material for aluminium electrolysis. The know-how for this process was given to many foreign countries and now there are such plants in the German Democratic Republic, Romania, Japan, Sweden and Jugoslavia.

EXCREMENTAL WATER AND INDUSTRIAL ORGANIC PROCESS WASTE WATER

It is known that organic substances from industry and house holds are discharged into rivers and lakes. Here the organic substances are digested by bacteria lining in the water. By this process CO_2 and H_2O are formed. This reaction is a basic reaction for the natural self-purification process in our water. This reaction can only take place in the presence of a sufficient amount of oxygen. In the absence of oxygen the micro-organisms cannot exist. Accordingly purification of waste waters is increasing in cases of decreasing of oxygen. Such reactions caused by micro-organisms are used to purify waste water in biological purification plants. These purification plants are installed before the waste water is running down to the rivers and lakes, so that only purified water is coming into them. In the purification plant an additional effect is obtained by bringing in much more oxygen by means of mechanical treatment. Besides, with this mechanical treatment of waste waters the sludge arising in the biological step is recycled. In this way a purification of waste water is guaranteed and only clean water is discharged into rivers and lakes.

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REGIONAL PURIFICATION PLANT LINZ

In comparison with many other rivers in densely populated regions the water quality of the Danube is not bad. In Austria we have water quality standards. The Danube in Upper Austria is of the class II and III of a basis of a valuation of four classes. As a barrage was built on the Danube in 1979 in connexion with erecting a hydroelectric power station near Linz, better water quality standards are now required. House hold wastes together with industrial wastes should be purified in the regional purification plant in Linz. This plant can purify all waste waters of the region of Linz including industries. So the waste waters of Chemie Linz AG, Vöest Alpine (steel works) and of the Enns sugar industries are purified in this biological purification plant too.

Apart from water resulting from households and business, organic waste water is coming from industry. Our plants also generate organic waste water. But we now are making great efforts in minimizing waste water. Generally people believe that only poisons are dangerous in waste water. Admittedly, poisons are very dangerous to natural self-purification processes, but all organic substances like now poisonous solvents, food staffs and detergents reduce the oxygen contained in the rivers and lakes.

This information should make you understand that pouring liquids down drain pipes in laboratories is surely not the right way to dispose of waste.

In principle all wastes should be separated from water. Further all mother liquors should be recycled and solvents should be recovered, because, as you know the purification of waste water in mixed and diluted states is much more expensive and technically more difficult.

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Nowadays clean water is too valuable to be used as a mean of transportation for waste disposal.

ACTIVITIES IN OUR WORKS SITUATED IN ENNS (NEAR LINZ)

In our new plants, situated in Enns, acrylonitrile is produced. Most of the waste water is incinerated. Only a small part of wastewater which it is not economical to burn has to be purified by biological treatment.
To realize these processes it is necessary to combine recycling steps and enrichment stages while minimizing energy consumption. In the past diluting of waste waters by cooling waters was desired in order to reach lower concentrations of emission in the waters. Such a dilution of waste waters is disturbing if a biological treatment of waste water is intended. In our plant in Enns a special sewage system is erected to separate cooling waters from biological treatment plants.

RECYCLING METHODS

At various stages in this paper recycling or recycling methods have been mentioned. As a matter of this principle raw materials are recovered from wastes and can be used for further reactions. Nowadays recycling is of great importance in dealing with waste.

In the chemical industry recycling methods have been applied long before environment at protection was born. The reason for such application was to improve the yields of chemical reactions. An example is the synthesis of ammonia by reacting nitrogen and hydrogen. Passing the reactants once leads to yields of 30 %. By means of recycling yields can be increased up to 98 %.

Another example is our gypsum sulphuric acid process. In the production of high quality phosphate fertilizers a great quantity of sulphuric acid is used to separate an undesired surplus of calcium from raw phosphate.

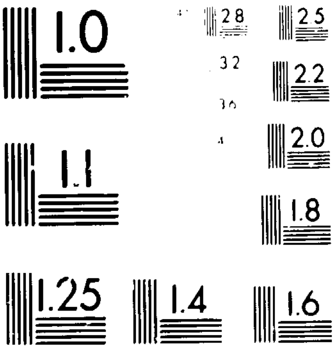
In this reaction $CaSO_4$ is formed, the so-called gypsum. This waste material is utilized to produce Portland cement and high-quality sulphuric acid simultaneously. Sulphuric acid is recycled to fertilizer production. This recycling of gypsum prevents the formation of giant waste gypsum heaps. On the other hand more than 100 000 tons per year of calcium sulphate can be saved from natural sources.

A further example from Chemie Linz AG is the recycling of lubricating oils and the work-off of fibre wastes and polyethylene wastes.

These recycling activites by Chemie Linz AG are the reason that not more than 1 % waste is produced in comparison to the total production of chemicals. 1 % waste is a very low value in comparison to 10 % in the great chemical plants of West Germany's industry or other industrial spheres.

WASTE DISPOSAL

Waste disposal is a great problem. Not all wastes can be carried to refuse pits. In Austria there are only a few possibilities for disposing or difficult wastes. Therefore it is necessary to remove these wastes in foreign countries, where they are burned in special furnaces. In our plants an organization for wastes has been installed, it is the organization plan which fixes each waste from production process and determines its disposal or its recycling.



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS

STANDARD REFERENCE MATERIAL 1010a

ANSI and ISO TEST CHART No. 2

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If disposal is chosen there exists a waste book which determines what has to be done with the wastes. In this manner all wastes are registered and their subsequent destins is determined.

It is not possible to review all these environmental problems in short. It is the aim of this report to show that chemical industries are able to solve their environmental problems within socially acceptable limits.

New technologies make it possible to realize more extensive laws for the protection of the environment. Developments so far let us view the future with optimism. This optimism seems to be very necessary, thinking of the great problems of the future, first the growth of world population and securing sufficient food for people, and secondly making a natural environment possible for the future.

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LEAFLET ABOUT HANDLING AMMONIA

1. PROPERTIES

1.1

Under normal conditions ammonia (NH_3) is a colourless gas with a characteristic pungent odour. It is readily liquefied by cooling or compression. The liquefied ammonia evaporates readily and fast at atmospheric pressure. This gives rise to a powerful refrigerating effect to 40oC below zero. Ammonia is very soluble in water, the saturated solution containing 35% NH_3.

Synonyms for aqueous solutions: aqua ammonium, water of ammonia, ammonium hydrate.

1.2

Liquid ammonia, concentrated aqueous solutions, gaseous ammonia in higher percentages have an irritating effect on the skin, particular the genitals, the respiratory tract and mucous membrane of the nose, due to an alkaline caustic action. Liquid ammonia can also cause frostbite. The pungent odour gives warning in due time.

Maximum allowable concentration in air (*M.A.C.) : 50 parts per million (=TLV: threshold limit value).

*M.A.C. = that concentration in a working atmosphere of a dust, fume or vapor such that if it is exceeded for appreciable periods damage can be caused to the health of the individuals exposed.

1.3

Fire and explosion hazards exist but are considered small.

2. HANDLING

2.1

Ammonia (gas or liquid) is best removed by spraying plenty of water into it.

2.2

Explosive limits: 16 to 25% by volume in air. At certain limitations (15.5 - 27% v/v NH_3) an ammonia/air mixture is explosive; naked flames or lights and smoking are therefore prohibited in rooms where such mixtures might occur. In case welding or jobs with naked flames really have to be done during erection or repairing work, this is permitted only with the special approval of the management of the company under adequate supervision and observing special precautions.

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2.3

The risk of poisioning and explosion necessitate the utmost care with all jobs at containers, apparatus, linings and fittings for ammonia (depressurizing, careful evaluation, blowing out with N2, repeated rinsing with water, disconnecting and closing the pipes). Mines and canals may be entered only with utmost care and using the appropriate breathing equipment. The precautions for accident prevention of the "Berufsgenossenschaft", encl. 4, section A are to be scrapalously observed.

3. STORAGE

3.1

Cylinders should be stored away from heat and sunlight.

3.2

They should never be dropped.

3.3

Connections to these cylinders should be tight. Care should be taken when opening containers, and gas masks worn.

3.4

Recommended storage: in fire-resistant structures away from chlorine, bromine, iodine and mineral acids.

3.5

Water is an effective fire-extinguishing agent.

4. TREATMENT

If liquid ammonia is spilt on clothing, all clothing should be removed immediately and the body thoroughly drenched with water. If ammonia gets into the eyes, they should be washed immediately with plenty of water; this may be followed by the introduction of a saturated solution of boric acid. If pain is severe use a local anesthetic such as a 0.5% solution of pontocaine hydrochloride. Thereafter the application of olive oil or some similar oil is desirable. Continuous warm boric compresses to the eyes may be of value. The usual treatment for corneal ulcers should be carried out and an ophthalmologist should be called at once. Respiratory and circulatory measures should be taken if the concentration of fumes has been severe and the respiration affected. Inhalations of 5 to 7% carbon dioxide in oxygen should be given, and if pulmonary edema ensues the use of oxygen by means of a tent or intranasal apparatus is advised.

5. PRECAUTIONS

5.1

Ammonia vapour is lighter than air (density = 0.6 in relation to air), therefore they escape overhead. Good ventilation overhead has to be cared for because of this. In the case of sudden ammonia escapes, for instance leakages from turbines, fittings or containers leave rooms as quick as possible, protect mouth and nose by holding moistened rags in front of them. Even a dry handkerchief or the sleeve of a jacket will do at an emergency at fire.

5.2

Leakages can be found by searching with a wooden or glass stick previously dipped into HCl solution of about 15% (be careful - corrosive!), or with moistened red litmus paper - in the presence of ammonia white mists form and/or the litmus paper changes to blue.

5.3

Absolutely necessary jobs in ammonia poisoned rooms (for instance operating valves, switching machines off, rescuing injured people) may be done only with suitable precautions, for instance: fresh air, compressed air or oxygen breathing apparatus and an impervious special suit to protect the body.

5.4

With oxygen breathing apparatus the filter K, identification colour green, is to be used. Stored in rooms with normal humidity, temperature and atmosphere, this type of filter will last for 3 years in unused condition when kept in the manufacturer's pack. After expiration of the maximum storage period even unused filters are not allowed to be used any more.

5.5

For work with ammoniac water (ammonia solution) well-fitting safety-glasses must be worn so that nothing can lash into the eyes.

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BALANCING AND MEASURING VIBRATION

1.Balancing

1.1 Introduction

Unbalanced centrifugal forces and momenta are undesirable because because of:

- high dynamic bearing forces -- reduction of useful life
- vibration -- fatigue fracture
- reduction of friction
- reduction of porduct value (employment)
- noisy machines
- influence on personnel

Balancing is the process of attempting to improve the mass distribution of a body so that it rotates in its bearings wihtout unbalanced centrifugal forces.

1.2 Measuring unbalance

Unbalance is a vector, therefore the amount and the angle of unbalance must be measured.

1.2.1 Centrifugal balancing machines

(balancing machines that provide for the support and rotation of a rotor and for measuring vibratory forces of motion due to unbalance in the rotor once per revolution)

a) Soft bearing (above resonance) balancing machine

(operating at a speed above the natural frequency of the suspension-and-rotor system)
Resonance balancing machine: a balancing machine operating at a speed equal to the natural frequency of the suspension-and-rotor system.
Compensating (zero force) balancing machine: a balancing machine with a built-in calibrated force system which counteracts the unbalanced forces in the rotor.
Direct reading balancing machine: a balancing machine which indicates the unbalance directly.

b) Hard bearing (below resonance) balancing machine

a balancing machine operating at a speed below the natural frequency of the suspension-and-rotor system. A dynamometer and an extremely rigid foundation and machine construction must be employed.

c) Field balancing

The process of balancing a rotor in its own bearings and supporting structure at full speed. Measurements are made with field balancing equipment.
Under such conditions the information required to perform balancing is derived from measurements of vibratory forces or motions of the supporting structure and/or measurements of other responses to rotor unbalance.

1.2.2 Indicating systems

- wattmetric indicating system
- voltmetric indicating system with phase-sensitive rectifier
- voltmetric system with stroboscope and filter
- voltmetric indicating system with marking of ungular position on the rotor itself
- compensator with mechanical or electric indication

1.2.3 Motion transducer

- piezo-electric motion transdueer: the voltage signal is proportional to the acceleration
- electrodynamic motion transducer: the voltage signal is proportional to the velocity
- inductive motion transducer: the voltage signal is proportional to the displacement

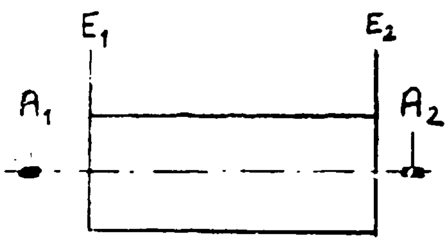
1.3 Balancing procedures

1.3.1 Static balancing

(is a condition of unbalance for which the central principal axis is displaced only parallel to the shaft axis)
For disk-shaped rotors the use of only one correction plane may be sufficient, provided the bearing distance is sufficiently large and the disk rotates with sufficiently small axial run-out. Single plane balancing can be done on a pair of knife edges without rotation of the rotor (gravitational - non rotating - balancing machine) but is now more usually done on centrifugal balancing machines.

1.3.2 Dynamic balancing

(is a condition in which the central principal axis is not coincident with the shaft axis)



E 1,2 ... Correction plane
A 1,2 ... Measuring plane

a) A run with the original unbalance.

The vectors,

$\overrightarrow{V_{1,0}}$

$\overrightarrow{V_{2,0}}$ are measured

b) A known trial mass (m1) is mounted in plane E1. The vectors V 1,1 and V 2,1 are measured. Remove the trial mass and note the position at 0oC.

c) A known trial mass (m2) is mounted in plane E2. The vectors V 1,2 and V 2,2 are measured. Remove the trial mass and note the position at 0oC too.

Evaluation

Graphic evaluation: rarely used because it is protracted and fallible.

Numercial evaluation: for equation see "Static and Dynamic Balancing". It is best calculated with a programmable calculating machine.

1.4 Balance Quality of Rotating Rigid Bodies

Even after balancing the rotor will possess residual unbalance. By means of the measuring equipment available today unbalance may now be reduced to rather low limits. However, it would be uneconomical to exaggerate the quality requirements. To which extent the unbalance must be reduced, and where the optimal economic and technical comprise on balance quality has to be struck, can be correctly determined in individual bases only by extensive measurement in the laboratory or in the field.

In general we can say:

The residual unbalance force: $F = m.r.w2$ m = unbalance mass
Acceptability limit: $F = G/10$ G = rotor weight

It follows: $m \; 10 \times \frac{G}{r.n^2}$ m (kg); G (N); r (m); N (min^{-1})

For example: $G = 100$ kg
$r = 100$ mm $m \; 10 \times \frac{1\,000}{0{,}1 \times 6000^2} \; 3 \times 10^{-3} kg = 3$ g
$n = 6000 \; min^{-1}$

Terms of reference are given by VDI 2060:

On the basis of section 1.4 balance quality grades have been established which permit classification of the quality requirements. Each quality grade Q comprises a range of permissible residual unbalances (e.w.).
See figure 1.

The quality grade Q equivalent to the centre of gravity-velocity. The centre of gravity-displacement is given by:

$e = \frac{Q}{W}$ Q (mm/s); w (s^{-1}); e (mm);

The permissible residual unbalance:

$m = \frac{e.G}{r}$ m(g); e (mm); G (kg); r (m)

For example:

G = 100 kg
r = 100 mm
n = 6000 min^{-1}
Q = 2.5
e = 0.004 mm
m = 4 g

In general, for rigid rotors with two correction planes, one-half of the recommended residual unbalance is to be taken for each plane. For disk-shaped rotors the full recommended value holds for one plane.

2. Measuring Vibration

2.1 Introduction

High vibration is undesirable, for the reasons given in section 1.1.

2.2 Hints for measuring

It is possible to measure displacement, velocity or acceleration. For evaluating

$$(s;\ v = \frac{ds}{dt},\ a = \frac{d^2s}{dt^2})$$

the vibration it is best to measure the rms-value of vibration velocity V rms.

$$V_{rms} = \sqrt[2]{\quad \frac{1}{T} \quad T \quad V^2(t)\,dt}$$

The vibration severity of a machine is to be measured at operational speed. For variable-speed machines the measurements should be made at many speeds in order to locate the resonance frequencies which may possibly occur.

The machine support may significantly affect the vibration levels measured on the machine. During testing the machine should be either mounted on its operational foundation or - in case it is a small assembly - soft mounted/suspended on springs.

Test sould be made preferably in x, y, z directions (choose the bearings of the machine).

2.3 Evaluation Standards

Comparing the measured values with the limit values specified in the recommendations, will permit an estimation of the severity of vibration to be carried out readily.

A machine may be qualified according to the examples of Quality Judgement (see "Vibration Signature Analysis Techniques and Systems"). At first the tested machine has to be classified according to one of the six specified machine classes. Subsequent-ly the limit values for the quality groups "good", "allowable", "just tolerable" and "not permissible", can be taken from the appropriate table. By comparing the measured vibration severity with these limit values an easy evaluation of the vibratory state can be made. Up to now, examples of quality judgement have been established by the International Standard Organization VDI 2056 for the machine classes K to T. The machines in classes D and S vary considerably in their vibration characteristics and for this reason a classification in the same manner as with the first four classes has not yet been possible. For further explanations refer to the detailed description of proposed VDI 2056, ISO 2372, BS 4675.

Definition of machine classes

Class K:

Individual parts of engines and machines, integrally connected with the complete machine in its normal operating condition (production electrical motors of up to 15 kW are typical of machines in this category)

Class M:

Medium-sized machines (typically electrical motors with 17 to 75 kW output) without special foundations; rigidly mounted engines or machines (up to 300 kW) on special foundations.

Class G:

Large prime movers and other larger machines with rotating mass mounted in rigid and heavy foundations which are relatively stiff in the direction of vibration measurement.

Class T:

Large prime movers and other large machines with rotating mass mounted on foundations which are relatively soft in the direction of vibration measurement (for example turbongenerator sets, especially those with lightweight substructures).

Class D:

Machines and mechanical drive systems with unbalanceable inertia effects (say, due to reciprocating parts), mounted on foundations which are relatively stiff in the direction of vibration measurement.

Class S:

Machines and mechanical drive systems with unbalanceable inertia effects (say, due to reciprocating parts), mounted on foundations which are relatively soft in the direction of vibration measurement; machines with rotating slackcoupled masses such as beater shafts in grinding mills; machines like centrifugal machines, with varying unbalances, capable of operating as self contained units without connecting components; vibrating screen, dynamic fatigue-testing machines and vibration exciters used in processing plants.

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F A U L T S

This survey of faults in operation is not focussed on a particular turbine - in other words it is of purely general interest.

1) lubrication and bearings
2) safety and monitor devices
3) control system
4) steam quality
5) blades
6) labyrinths (shaft seals)
7) noise and vibration
8) general points

1) Lubrication

1.1 Bearing temperatures rise

If bearing temperatures rise, this represents a serious danger to the turbine, which must therefore be shut down immediately if no success is achieved in dealing with the cause listed below and lowering the temperature to the values given in the data sheets. Various factors may be responsible for bearing temperatures rising:

1.11 Shortage of coolant water:
This means that cooling is inadequate, which can be recognized by a rise in outlet temperature of both oil and water from the oil cooler.

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1.111 Coolant water inlet temperature too high

1.112 Oil cooler clogged:
This may affect either the water or the oil side; it is revealed by the oil outlet temperatur rising while the coolant water outlet temperature stays the same or goes down (see section 1.34).
If 2 oil coolers are installed, switch over.

1.113 Insufficient bleeding on the coolant water side of the oil cooler: interferes with heat transfer as in 1.112 (see section 1.12 for bleeding on the oil side).

1.12 Shortage of oil:

1.121 Shortage of oil is revealed by a drop in oil pressure; it is due either to the oil reservoir sinking too far, or to insufficient bleeding of the oil cooler, oil filter - particularly in twin systems - or other leads to unsatisfactory cooling and inadequate lubrication.

1.122 Oil filter clogged:
If spring-loaded bypass valves are fitted,non-purified oil enters the bearings (see section 1.3).
Keep an eye on the pressure drop or the pressure drop indicator. If a twin oil filter exists, switch over.

1.123 The auxiliary oil pump gets switched off too soon after the turbine has been shut down - keep an eye on bearing temperatures and switch auxiliary oil pump back on. The process of final cooling down is concluded only when the heat stored in the impeller and and housing has been conducted away (see secion "shut down" in the user manual). Keep to the guidelines provided by the AEG-Kanis staff on site during commissioning.

1.124 Replacing oil cooler:
If the oil cooler is not replaced properly, damage will result. To reduce the risk of this happening as far as possible, it is a good idea to affix a flowsheet next to the oil coolers.

1.13 The causes listed above apply in the case of insufficient heat dissipation in relation to constant heat input. However, it can happen that heat is dissipated satisfactorily in line with the design data, but excessive heat is input and leads to a bearing temperature rising. Examples of such causes:

1.131 Rough running due to serious mineral despits on blades (increased frictional heat)

1.132 Increased axial thrust on the thrust bearing in the case of serious heavy mineral deposits due to increased impeller chamber pressure (increased frictional heat)

1.133 Vibration in the machine driven transmitted to the turbine

1.134 Incorrect alignment (increased frictional heat)

1.135 Extended turbine operation with steam conditions for which it was not designed (e.g. running without a load for too long: the bearing on the exhaust steam side gets too hot)

1.136 Damage to bearing metal, due to mixed friction

1.137 Damage to bearing metal and bearing surfaces as a result of storage and/or transport

1.138 Interference with free thermal expansion (serrated coupling jams)

1.139 Shims yield

1.14 Unexpected causes which can neither be identified quickly nor dealt with at once.
If suitable measures (e.g. for sections 1.131 to 1.135 providing spare capacity in the design of the heat dissipation system) fail to lower the bearing temperatures to the levels specified, the turbine must be shut down.

1.2 Lubricant oil pressure too low

This will cause damage to the turbine; so the auxiliary oil pump must be switched on at once, possibly by a monitor device in the automatic switching-on mechanism. Possible causes:

1.21 Main lubricant oil pump no longer pumps

1.22 Main oil filter clogs:
In the case of filters with a relief safety bypass, these by-passes open, so the supply of oil to the turbine continues. Open and clean the oil filters.

1.23 Shortage of oil due to leaks:
Can easily be detected from the oil level (cf. section 1.12). At this point the turbine manufacturer recommends fitting a mechanical lock on the shut-off valves on the oil pumps and oil reservoir, so that they cannot be closed by accident or by unauthorized persons.

1.24 Rise in oil supply temperature

1.25 Insufficient final cooling time for the bearings after shutting down. If in doubt, cool down for too long rather than too short a period. (Cool down either with the auxiliary oil pump or with a special final cooling pump.)

1.26 Unforeseeable causes which can neither be rapidly identified not dealt with at once.

Note

In some oil system circuits the bearing oil pressure drops from a higher value to that specified in the data sheet as the turbine speed increases to operating speed. This is due to the increasing suction of the bearing with increasing speed, and should not be regarded as a fault.

1.3 Lubricant oil contaminated

The function of the oil aggregate is of crucial significance for the turbine set to operate reliably. Contaminated oil must therefore be avoided as a cause of faults during operation.

As a matter of principle, the oil aggregate gets flushed out before starting up for the first time (flushing oil removed; lines, oil reservoir, filters, etc. cleaned with care); see supplement 4a.

1.31 After start up keep a careful eye on the oil filter (pressure drop or pressure drop indicator) and clean it regularly. Once the turbine has been commissioned, clean the oil filter at regular intervals: once a week at first, later once a month.
Keep records of this!
In the case of twin filters:
switch over and clean the off-stream filter

1.32 Aggregates with separate oil reservoir:
A partition divides the oil reservoir into the return half and the supply half. An oil strainer its built into this partition in such a way that it can be removed together with its mounting frame. As a basic rule, the strainer should be cleaned at regular intervals after commissioning, say once a week. Whether the strainer in the partition has accumulated much material can be seen from the oil levels ahead of and beyond it; levels will be significantly different only if the strainer needs cleaning.

A draining valve is located at the deepest point of the sloping reservoir floor on each of the partition. The sludge draining valve is located ahead of the strainer. To drain the oil reservoir completely, both valves must be opened (because of the partition).

1.33 If condensate has got into the oil circuit, it should be drained off with the 2 drain valves only after the system has been shut down for around 12 hours, to give it time to settle out.

Draining condensate out of the oil reservoir:
Take an oil sample once a week and test it for condensate.If condensate is present, it may be necessary to drain it off with the machine running, until clear oil comes out. However, it is naturally preferable to drain condensate off only after the system has been shut down for 12 hours.

1.34 Cleaning the oil cooler:
Depending on the extent of contamination (see section 1.112), the oil cooler(s) must be cleaned at least once a year - both the water and the oil side. When removing the tube stack, take great care that the gland packing is not damaged; it must seal the sliding head efficiently. If necessary, replace the packing.

1.35 Do not hose the outside of the oil resrvoir down to clean it - there would be a risk of water preheating into the reservoir (cf. supplement 4a, section 4).

1.4 <u>Damage to bearings caused by running backwards</u>

Experience has shown that, when turbo compressors and turbo pumps are switched off, there is a risk of the non-return valve in the pump/compressor delivery pipe jamming and failing to close (or leaking), so that after slowing down machine and turbine rotate in the reverse direction. This is not good for lubrication, and the bearings get damaged as a result, possibly in conjunction with damage to the labyrinth seals and blades. (The thrust bearing is designed only for rotation in one direction).

Before switching off, ensure that the non-return valves move as freely as possible; if the pump/compressor still runs backwards, apply countersteam immediately until the non-return valve is closed. The turbine must turn in the intended direction. The tachometer does not indicate turning in the wrong direction.

The delivery pipe on the main oil pump driven by the turbine shaft is usually equipped with a non-return valve, so that the oil pumped by the auxiliary oil pump cannot be drawn in the wrong direction.

Important

Every time that damage occurs to a bearing, check the turbine for correct alignment; realign with care if necessary!

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2) Safety and monitor devices

2.1 Emergency shutdown triggered by excessive speed

Possible causes:

2.11 As excessive speed may be due to a control valve spindle jamming, check this by reading the valve scales before starting up again (see section 3.11)

2.12 Pressure in delivery pipe suddenly dropping, in the case of compressor/pump drives

2.13 If an emergency shutdown is caused by excessive speed, the following points should be noted:

2.131 Allow the turbine to slow down to half speed

2.132 Reset the emergency shutdown valve by turning to the right all the way to the stop, and latch it in place

2.133 Latch the emergency shutdown device in place only when the turbine speed has gone down to roughly half of rated speed

2.134 Set the speed setpoint to the lowest possible value

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2.135 Before speeding up turbines with oil pumps driven by the turbine shaft or transmission again, check the lubrication oil pressure. If necessary, switch the auxiliary oil pump on (if it does not start up automatically).

2.136 The turbine is ready to start running again, once the emergency shutdown device is back to normal and the cause of its being triggered has been identified and dealt with.

2.2 Emergency shutdown due to excessive wear on the thrust bearing

Applies to turbines with axial position monitor. Excessive wear occurs in the case of mineral deposits as a result of the increased impeller chamber pressure, which leads to increased axial thrust. In addition, axial vibration of the machines driven cause increased wear via the pressure of the coupling serrations on the turbine impeller.
The axial pressure gauge reveals the degree of wear. Before the limit values specified in the data sheet are reached, appropriate steps must be taken; if necessary, ask for a fitter to be dispatched. The turbine is at risk, and if possible it should not run until the damage has been repaired. Do not change settings.

2.3 Other forms of emergency shutdown

As regards any other emergency shutdown devices possibly included in the supply schedule, which are connected to the 3-way solenoid valve by means of temperature or pressure-dependent contact devices or act on the emergency shutdown system hydraulically, the user manual should be consulted if a fault develops; if necessary, it is advisable to get in touch with the manufacturers.

2.4 Damage to/faults in emergency shutdown valves

2.41 Sealing surfaces:
due to foreign matter
due to excessive loading
due to the guide sleeves being detached
due to erosion of the sealing surfaces
due to the cone wobbling as a result of pressure equalization

2.42 Glands:
due to being one up too tight (valve does not close)
due to mineral deposits (valve does not close)
due to unsuitable packing material
due to roughness on spindle
due to packing being inserted incorrectly

2.43 Dealing with faults discovered:
by means of regular checks for smooth running (see supplement 16 or 16a)
by partly closing the valves to dislodge mineral deposits, without turning the turbine down

Important
If the emergency shutdown valve glands emit steam and get tightened up to seal them again, it is essential to check that the valve in question moves freely afterwards. To do this, trigger an emergency shutdown, or close valve by hand. The closing movement must not be impeded in any way.

2.5 Safety features

2.51 The automatic starter for the electric auxiliary oil pump may fail because it is connected up incorrectly or set wrong.

2.52 The automatic starter for the auxiliary oil turbo pump may fail because it is connected up incorrectly or set wrong. The manufacturers recommend fitting a bypass with the appropriate shut-off valves in the live steam line to the turbo pump, so that, if the automatic device does not work, it is possible to intervene manually to ensure the supply of oil.

2.53 Spring-loaded safety and relief valves frequently cause critical fluctuations in the flow both of steam and of oil. This can be cured by:

2.531 A slight change in the setting

2.532 Fixing/supporting the valve, i.e. securing it against vibration mechanically

2.533 Refitting the safety valve at a different point on the line

2.534 If none of the methods just listed cures the fault, the only possibility is to replace the valve with the next size up or a different type.

Note

Unless the safety devices work satisfactorily, the turbine operation is at risk.

2.6 Monitor devices

All indicators, recorders and alarm devices are of great importance for trouble-free turbine operation; if they develop faults, they must therefore be repaired or replaced.

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3) **Faults in speed control**

3.1 Nozzle group control valves

3.11 Mineral or other deposits may lead to a control valve jamming, so that the force of the closing spring is insufficient to close the valve. In this case the turbine must be shut down and the valve dismantled and cleaned. If the turbine stays in operation for any reason, it is possible - as an emergency measure - to modify the opening sequence of the valves shown in a setting schematic (normally diagram 33). One can try to close the control valve in question by tapping it gently, using a soft (copper) drift.

As a preventive measure, we recommend modifying the load from time to time, in order to prevent deposits forming on the control valve spindles. It is possible to simulate changes in load by throttling the emergency shutdown valve somewhat; the control valves then open fully and desposits are dislodged.

3.12 As a result of fluctations in the steam mains (which may be caused by the boiler, by a safety valve or by a pressure reducing unit) a valve spindle can sometimes shear due to alternating stresses. In such cases the turbine must be switched off and the valve in question dismantled. As an emergency measure, it may be necessary to replace it with a dummy.

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3.13 Valve setting altered or unsiutable:
use the setting schematic (normally diagram 33) to check this and cortect it.

3.2 Speed controllers

If speed controllers jam, this is almost always due to contaminants.

Faults in:
speed controller supplied by KALB: see supplements 71/71a/71b/71c
speed controller supplied by Jahnss: see faults section in user manual (list of contents, V2)
speed controller supplied by Woodward: see Woodward documentation (documentation index in user manual)
other speed controllers: see faults section in user manual (list of contents, V2)

3.3 External causes

The live steam pressure (and possibility the blending or reaction pressure fluctuates, and thus affects the functioning of the speed controller. This is usually due to a pressure reducing unit not working properly, or to a safety valve on the boiler causing changes in pressure.

4) Condition of steam

4.1 Contamination with minerals

For types of contamination, and procedures for getting rid of them, see the full explanation given in supplement 43.

The mineral content of live steam can form deposits on runner and guide blades, thus gradually restricting the cross-sections of the turbine. The extent to which the turbine has been fouled can be judged from impeller chamber pressure and exhaust steam temperature; it is therefore important to keep a careful check on these.

If the live steam does not meet the purity specification given in supplement 68, mineral deposits may develop after a time in some circumstances. There is no way of knowing in advance, though, which parts of the turbine mineral will be deposited in - this depends on many different factors.

Mineral deposits in the initial stages cause an immediate increase in impeller chamber pressure; on the other hand deposits in the later stages have very little effect on impeller chamber pressure, but are associated with increased exhaust steam pressure. However, this last point applies only above the saturation line of the i/s diagram.

It is advisable to take advantage of any possibilities in existence for connecting up pressure gauges, and to pay attention to their readings. As a general rule, the turbine will be at risk if the pressure rises above the impeller characteristic curve. In all doubtful cases the manufacturers should be called in.

Results of minerals being deposited:

4.11 Drop in performance due to simultaneous reduction in adsorption capacity and in the thermal head made use of

4.12 Excessive load on thrust bearing

4.13 Excessive load on labyrinth glands

4.14 Excessive load on blades

4.2 Foreign bodies in steam

To protect the turbine from foreign bodies, a steam strainer is located upstream of it; this retains any objects above a certain grain size. Before the turbine is commissioned, it is essential to ensure that the steam lines are clean. If work has been carried out on a steam line, it will certainly be necessary to clean it again. Small foreign bodies have the same effect on the blades as sand blasting, i.e. the turbine will certainly be damaged as a result.

The wire mesh (wire gauge 0.4 mm, mesh size 0.6 mm) provisionally fitted over the steam strainer should be removed within 4 to 6 weeks of commissioning, partly because of the pressure drop and partly because it has only a short service life.

4.3 Water in steam

It is essential to prevent any entrained water in the steam reaching the turbine. In the circumstances indicated in supplement 1, it will therefore be necessary to install water traps in the live steam line or in secondary steam feeders.

5) Blades

Damage to the blades may be the result of corrosion and pitting: the load-bearing blade cross-section is weakened and the sympathetic vibration frequency changed. This usually leads to fatigue failure. Turbines must not be damp (exposed to moisture) when stationary. In line with supplement 1, shut-off paths should therefore be used to prevent corrosion of the stationary turbine. In addition, the instructions for conservation given in supplement 37 must be complied with.

Most forms of damage to the blades are due to mineral deposits, water shock, water in steam of foreign bodies. Close attention should therefore be paid to section 4 of these instructions.

Fouling can occur if the rotating device is not switched on as and when the turbine gets preheated. Preheating the turbine when stationary is not permissible, regardless of whether live steam or countersteam is used for this. Fouling can also occur if the rotating device is not switched on for uniform final cooling, in which case the non-uniform cooling which may then occur leads to the impeller warping. The situation is the same if the rotating device breaks down during final cooling, and is to be started up again after the fault has been cured. In such cases it is absolutely essential to rotate the turbine runner at least 2 full turns, using the hand wheel on the rotating device motor or a suitable auxiliary device, before applying power. If possible the turbine should be rotated for approx. 1 hour before starting up. After starting up, check that the turbine runs smoothly at low speed. Only if the turbine gets heated through uniformly is the runner straight, and smooth running ensured. Only then can the turbine be run up to full speed without risk.

6) Labyrinths (shaft seals)

If a labyrinth seal is damaged (by radial or axial fouling) it will usually leak too much steam and therefore need replacing.

Possible causes of damage

6.1 Fouling at excessive relative expansion - pay attention to running-in times

6.2 Incorrect handling when openingthe turbineor when fitting/ removing the labyrinths

6.3 Excessive impeller chamber pressure due to mineral deposits

6.4 Impeller warping due to asymmetrical heating up or cooling down when stationary, followed by incorrect starting up

Damage to labyrinths as a result of

6.5 damage to a bearing:
6.51 running bearing damage (leads to radial fouling)

6.52 thrust bearing damage (leads to axial fouling)

7) Noise and vibration

If unusual noise is heard shut the turbine down immediately, get in touch with the manufacturers.

7.1 Drive to turbine incorrectly aligned. Check alignment, and realign using the values defined in the aligning instructions.

7.2 Causes of noise

7.21 Noise from the machine: investigate the cause

7.22 Noise in serrated couplings:
due to inadequate lubrication, due to incorrect aligning, due to the swelling of turbine, transmission or machine (deviating from the alignment instructions), due to acid vapors, due to employing used lock plates, due to deposits

7.23 Noises from turbine:
shut the turbine down, turn by hand as mechanical check, check the bearings, check the labyrinths, check the running tolerances, inspect the blades, check for: foreign bodies, unsatisfactory rebalancing, rebalancing without half coupling

7.3 Swelling due to heating up:

Any possible swelling (in particular affecting the exhaust steam pipe) during heating up must be taken into account in aligning the turbine. If noise develops, realign.

7.4 Rough running:

This is due to blade damage, a warped impeller or incorrect aligning. Asymetrical deposits on or erosion of the blade, or shifts in the position of the windings in the generator, can cause imbalance and thus rough running. Pay attention to critical speeds as applicable!

8) **General points**

If the instruction given in the user manual are complied with consistently, faults will be kept to a minimum and the extent of damage can be limited effectively if a fault does occur.

8.1 Operate the turbine only with the technical data given. This covers: live steam pressure, steam temperature, exhaust steam pressure, rate of temperature change, speed, bearing temperatures, oil pressures

8.2 Comply with the inspection/testing instructions provided.

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TROUBLESHOOTING

The table below lists the main sources of trouble, possible causes and the remedies advised. If none of the remedies mentioned cures the fault, you should get in touch with Nuovo Pignone, Florence.

FAULT	POSSIBLE CAUSES	REMEDY
vibration in and unusual asounds from compressor	incorrect alignment	dismantle coupling. Run drive unit alone. If the drive unit runs vibration-free, the fault may be due to wrong alignment. To check alignment, please refer to the corresponding section of the user manuals.
	damage to coupling	check state of coupling
	compressor rotor unbalanced	inspect the rotor to find out whether the fault is due to dirt accumulating; if necessary, re-balance
	wear in bearing due to contaminated oil	check the bearings and replace if necessary
	forces transmitted to the housing via the gas lines, leading to incorrect alignment	the pipelines must be properly anchored to avoid excessive forces acting on the compressor housing. The lines must be sufficiently elastic to accomodate thermal expansion.

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	imbalance in coupling	dismantle coupling and check for correct balance
	pumping	separate the operating conditions of the compressor from those of the pumping
	machines running close to the compressor	isolate the foundation pads in question and from each other, and increase the elasticity of any connecting pipelines
damage to support bearings	incorrect lubrication	check whether the oil used corresponds to that recommended. Check at regular intervals whether the oil is free of water and contaminants.
	incorrect alignment	check the alignment and correct if necessary
	bearing clearance does not comply with drawing	check the clearance and correct if necessary
	imbalance in compressor or coupling	refer to the corresponding sections under the heading "vibration"

damage to thrust bearing	excessive axial pressure	check whether the coupling is clean and installed so that excessive axial pressure is not transmitted from the machine coupled up to the compressor
	incorrect lubrication	refer to the corresponding section under the heading "damage to support bearings"
damage to oil seal rings	incorrect alignment and/or vibration	refer to the corresponding section under the heading "vibration"
	dirt in oil	check the state of the filters, and replace clogged filter inserts. Check that the pipes ar clean.
	ring clearance does not comply with drawing	check the clearance and correct if necessary
	insufficient oil pressure	check that the pressure of the reference gas does not drop below the prescribed minimum value