Cooper-Bessemer Company

Applied Mechanics Report

AM-3371

#[redacted]
106377
106377T

Celanese Chemical Company

RFB-24

SO-4555 MO-987RC

Torsional results are presented.

Submitted by

R. W. Harvey

November 7, 1974

AM-3371
11-7-74

This RFB-24 compressor, rated 3900 hp at 5320 rpm, will be driven by a Turbodyne steam turbine, which has a design speed range of 4400 to 6070 rpm. The main drive coupling will be a Zurn 103 FEL Amerigear coupling.

The predicted torsional natural frequencies are:

Mode	Frequency, cpm
1	3,650
2	23,040

This unit will be satisfactory torsionally.

Submitted by

R. W. Harvey

R. W. Harvey

/n

Approved by

J. W. Roeder

J. W. Roeder

Distribution:

A. A. Albright (3)
AM-3371

COOPER-BESSEMER COMPANY

Centrifugal Compressor Design Report

Celanese Chemical Company

RFB-24

SO-4555 MO-987RC

Lateral Results Are Presented

By R. H. Meier

November 21, 1974

The rotor system of this centrifugal compressor was analyzed for lateral natural frequency response.

This rotor system is of a single stage, overhung mass design and includes half of the complete drive coupling (Zurn 103 FEL Amerigear). In service, this rotor system is designed to operate continuously between 4400 and 6070 RPM.

The theoretical analysis indicates a first bending mode to occur at 7885 RPM. This is based on the realistic assumptions of total equivalent dynamic support stiffnesses of 600000 and 200000 lbs/in for impeller end and drive end bearings respectively.

Considering both lateral natural frequencies and operating speed range, this compressor rotor system will operate satisfactorily.

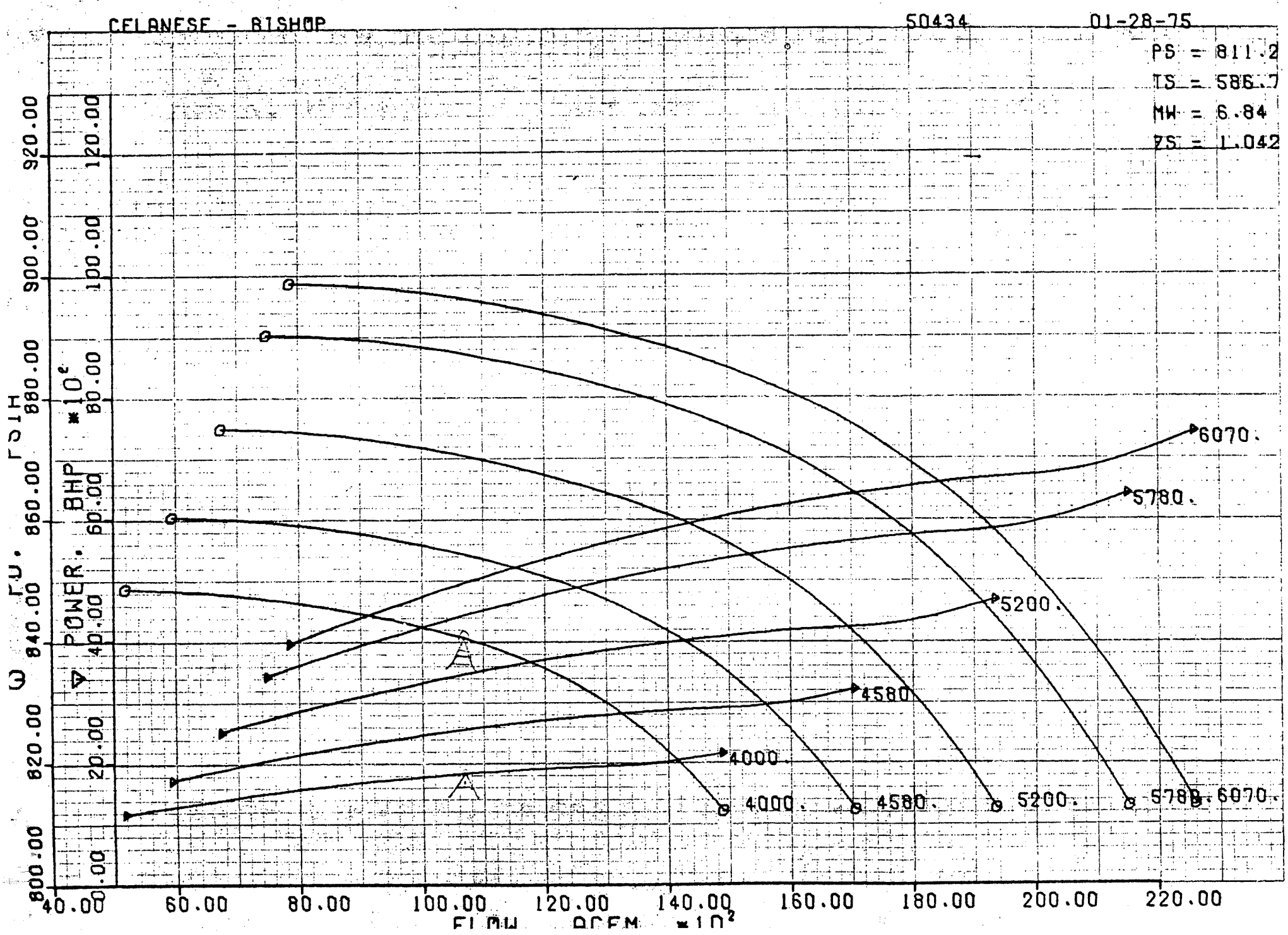
Submitted by

Robert H. Meier

R. H. Meier

/php

NORMAL OPERATIONS (WITH 4000 rpm PLOTTED)



File: Recycle Compressor Book

CELANESE - BISHOP

NORMAL OPERATIONS

PS = 811.2 = 796.5 psig
TS = 586.7 = 126.7°F
MW = 6.84
ZS = 1.042

BRAKE HORSEPOWER X 10-2

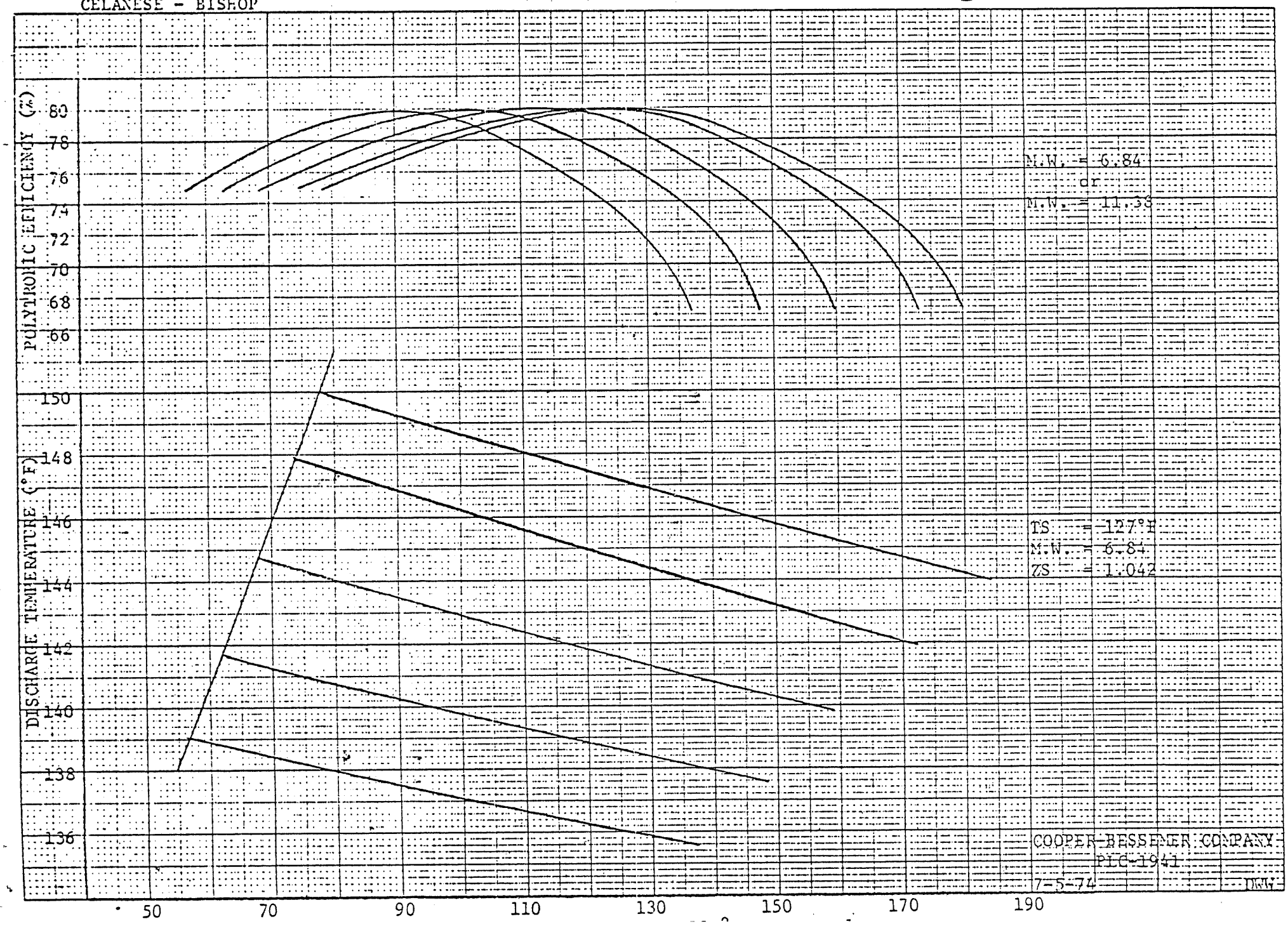
6070 RPM
5780 RPM
5320 RPM
4850 RPM
4400 RPM

SYM. LOOP RESISTANCE CURVE (NO CATALYST BREAKAGE)

COOPER-BESSEMER COMPANY
PLC-1938
7-3-74

NORMAL OPERATIONS

CELANESE - BISHOP



N2 @ 90 PSIG

CELANESE - BISHOP NITROGEN

P_s = 104.7
T_s = 559.7
MW = 28.02
Z_s = 0.999

POWER, BHP X 10+1

105.00 120.00 140.00 160.00
120.00 125.00 130.00 135.00
100.00 80.00 60.00 40.00
115.00 110.00 105.00

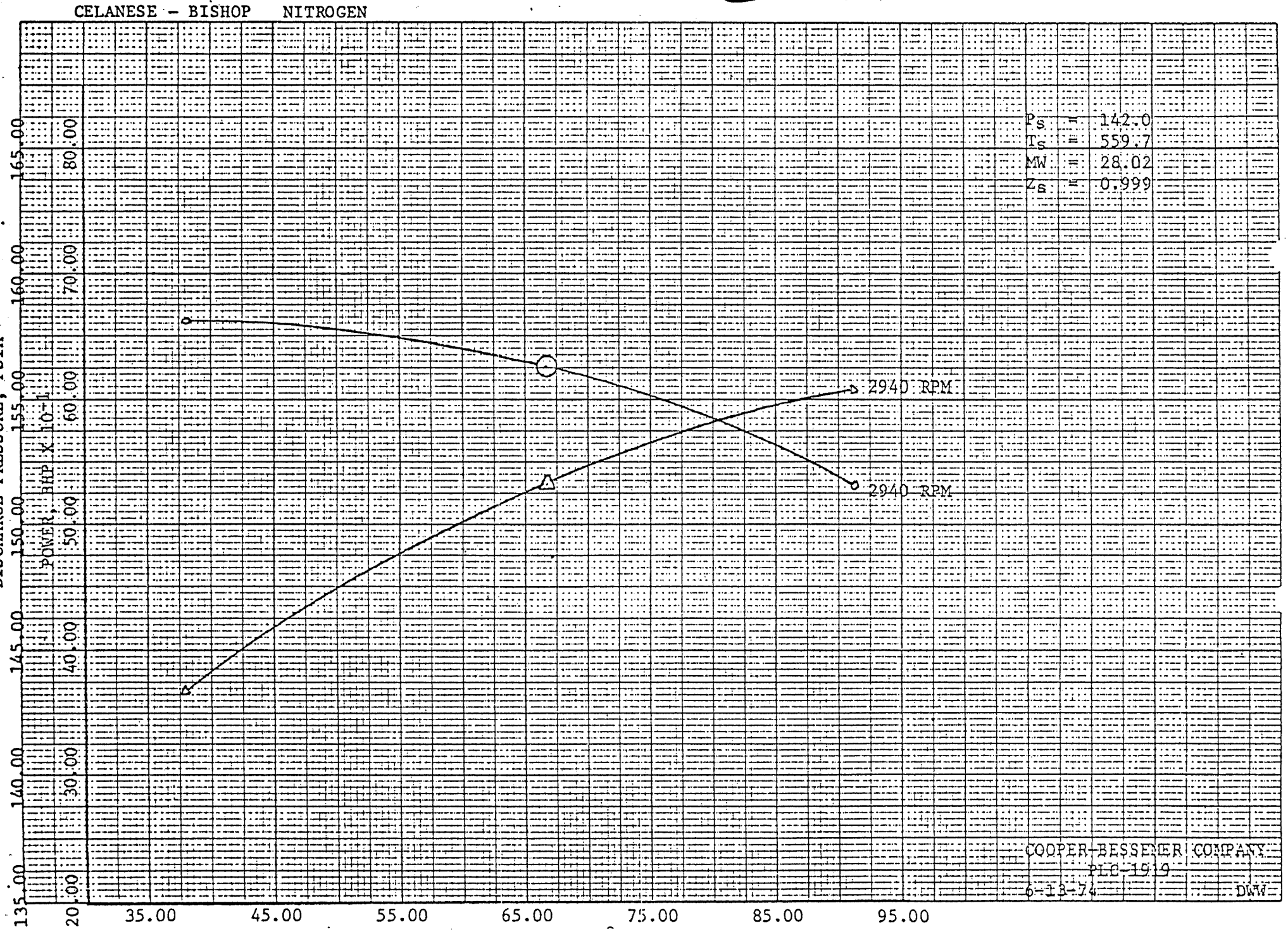
4000
4000

30.00 50.00 70.00 90.00 110.00 130.00 150.00 170.00

COOPER-BESSEMER COMPANY
PLC-1918
6-13-74 DWW

N2 @ 127 PSIG

CELANESE - BISHOP NITROGEN



CO2 CASE

CELANESE - BISHOP

IS = 811.2
TS = 586.7
HW = 11.38
ZS = 1.015

6070 RPM
5780 RPM
5320 RPM
4850 RPM
4400 RPM

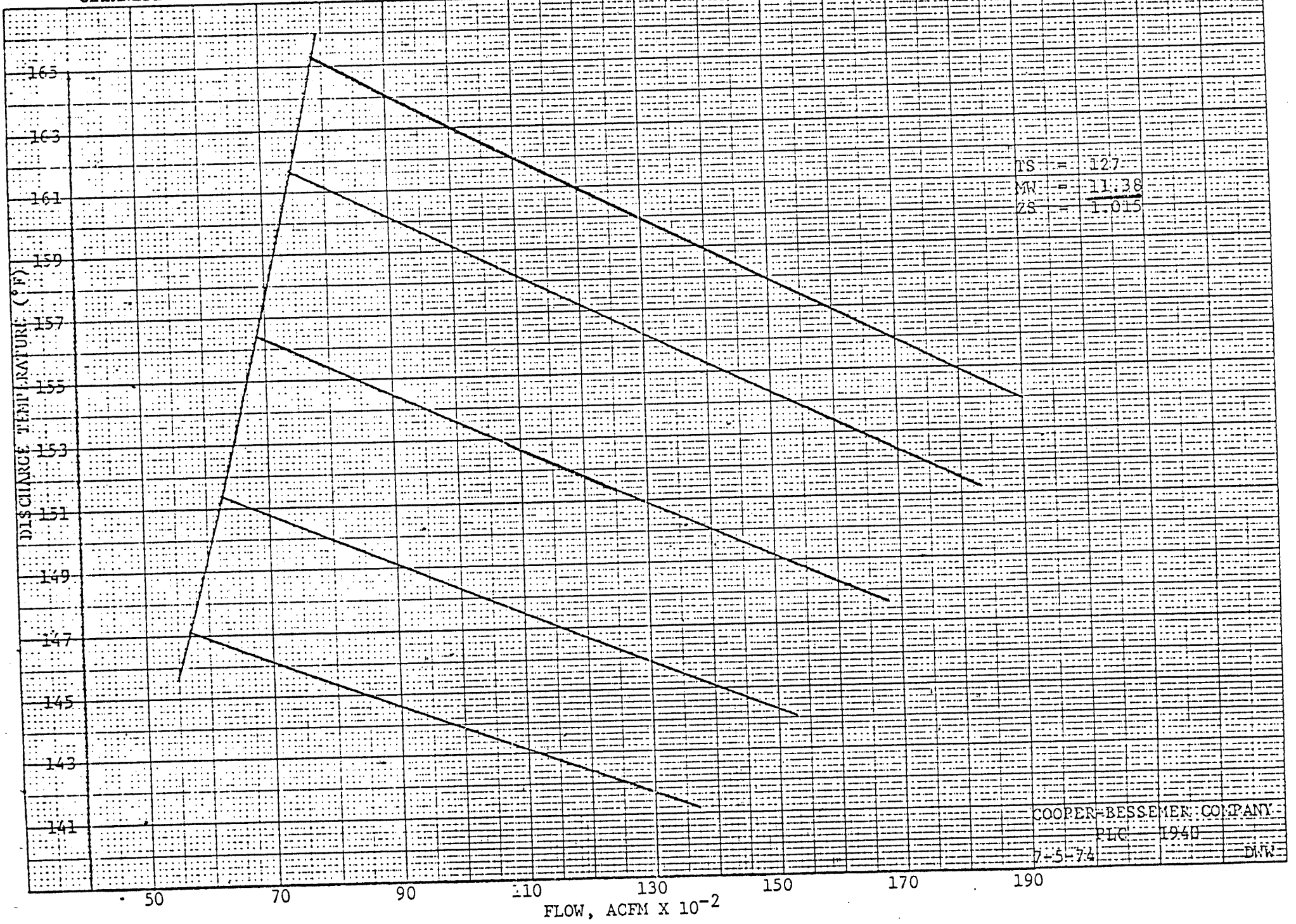
BRAKE HORSEPOWER X 10-2

FLOW, ACFM X 10^{-2}

COOPER-BESSEMER COMPANY
PLC-1939
7-3-74
DWN

CO2 CASE

CELANESE - BISHOP



COOPER-BESSEMER COMPANY
PLC 1940
7-5-74 DWW

BROWN & ROOT Inc. HOUSTON, TEXAS

CONT. NO. ER-0995

STEAM TURBINE DATA SHEET FOR [redacted]

TURBINE TO MEET PURCHASERS' SPEC. S-50.03-01

SPEC NO 149-M-15-DS

BY JHK 9/17/74 REVIEWED APPROVED BCS DATE 11-13 SHT. 1 OF 2

CLIENT CELANESE CHEMICAL CO.
DESTINATION BISHOP, TEXAS
UNIT STEAM TURBINE F.D. FAN
ITEM PT-1222 NO. REQ'D. ONE JOB NO. ER 0995
DRIVEN EQUIPMENT FORCED DRAFT FAN THRU GEAR REDUCER

MANUFACTURER TURBODYNE
TYPE & SIZE 202 WHB
SERIAL NO.
QUOTE NO. 30-216-74 DATE 7-5-74
PURCHASE ORDER NO. 50022 DATE

OPERATING CONDITIONS

ITEM-COND:	RATED	DESIGN	NORMAL	MINIMUM
HORSEPOWER:	440		295	
SPEED (rpm):	4760		4120	
INITIAL PRESS (psig)	240	250	240	240
INITIAL TEMP (Ftt):	SAT.	SAT	SAT.	SAT.
EXH PRESS (psig/in.Hg.abs):	55	55	50	40
EXH TEMP (Ftt):	SAT		SAT.	SAT.
* HAND VALVES OPEN:				
* WATER RATE:				

MAX.CASING PRESSURE (psig)
MAX.ALLOW.PRESS.EXH.END (psig) 75
INDOOR OUTDOOR X ROOF: Yes - No
WINTERIZATION: Yes - No
DUTY: cont. X intermit stand by hrs/yr 8760
STEAM COST: $/M# PAYOUT PERIOD (yrs)

CONSTRUCTION FEATURES

TYPE: vert horiz. X NO STAGES: single X mult
ROTATION (from gov end): cw (ccw) YES
GOVERNOR: mech hydr oil relay NEMA class D
CONTROL: WOODWARD PG-PL

GOVERNOR VALVE TYPE: single X mult
AIR HEAD FOR INSTRUMENT CONTROL JACK SCREW
Range 40 % below 4760 rpm
Max. rpm @ 5000 AT 15 psig Min rpm @ 2850 AT 3 psig
HAND SPEED CHANGER: range 5000 max rpm 2850 min rpm
TRIP-THROTTLE VALVE: separate COMBINED
Remote trip YES, SOLENOID Actuation DE-ENERGIZED
Other trip LOCAL Actuation MANUAL
Other trip EMERGENCY Actuation MECH. GOV
SOLE PLATE YES BASE PLATE FURNISHED BY VENDOR
Turbine Turbine & Gear Driven Eqpt.
STEAM INLET: rating 600 facing RF orient RT. UP
EXHAUST: rating 150 facing RF orient LFT. SIDE

* DRAINS:	no.	type & size	
* VENTS:	no.	type & size	
* WATER CONN:	no.	type & size	
* LUBE OIL INLET:	no.	type & size	
* LUBE OIL OUTLET:	no.	type & size	
* SEAL STEAM CONN:	no.	type & size	
* GLAND DRAIN CONN:	no.	type & size	
* INSTRUMENT CONN:	no.	type & size	
* OTHER CONN: service			
type & size			

BCS 11-13 12-27
11-5-74
CHKD. DATE

CONSTRUCTION FEATURES (cont.)

COUPLING: make BY GEAR VENDOR type
Mount Coupling Half: YES (Yes) No
Lubrication: Mounting: TAPERED-NEMA
Furnished by: GEAR VENDOR
INSULATION: Yes - No type INSULSTUDS FURN.
JACKET: Yes - No type
GEAR UNIT: required YES type SINGLE HELICAL
↳ BY PURCHASER

TURBINE SPECIFICATIONS

NO. OF STAGES SINGLE
ROTOR TYPE: solid built up ✓
SPEED (rpm): max.allow 5000 1st crit.* trip 5500
NO. AUTO VALVES: — TYPE LIFT: cam — bar —
BEARINGS: radial type & size SPLIT SLEEVE JOURNAL
THRUST: type & size BALL
PACKING TYPE: end glands CARBON RINGS
Interstage Diaphragms NONE

MATERIALS: TBD
Steam Inlet Parts CARBON STEEL - CL II
Casing C. STEEL Shaft HOT ROLLED ALLOY
Nozzles S.S. Nozzle Rings S.S.
Wheels C. STEEL Blading S.S.
Shrouds S.S. Gov. Trim Valve S.S.
Labyrinths NONE
Shaft Material Under Packing S.S. - 12 CR
Applied By: spraying X plating —
NET WEIGHT: SHIPPING WEIGHT: *
ROTOR WEIGHT: *
WEIGHT HEAVIEST PIECE FOR MAINT: *
FURNISHED BY OTHERS

GEAR SPECIFICATIONS

MANUFACTURER DESIGNATION
BUILT IN SEPARATE
NO. OF REDUCTIONS RATIO
CL. to CL. OF SHAFTS FACE WIDTH
TYPE OF BEARINGS TYPE LUBR
AGMA GEAR: service factor type
ROTATION L.S. (from gov end): cw ccw
SPEED OF L.S. (rmp):
LUBRICATION:
NET WEIGHT: SHIPPING WEIGHT
WEIGHT HEAVIEST PIECE FOR MAINT:
MATERIALS:
Case Shaft
Case Pinion
Brgs

* TURBODYNE TO CALCULATE & REPORT FOR RECORD

BROWN & ROOT, Inc. HOUSTON, TEXAS

BROWN-BILT

ER-0995 REV.
149-M-15-DS
SHT 2 OF 2

Item No. PT-1222

GEAR SPECIFICATIONS (cont.)

COUPLING: make _____ type _____
Mount Coupling Half: _____ Yes - No
Lubrication: _____ Mounting: _____
Furnished by: _____

LUBE OIL SYSTEM

TYPE: BY OTHERS, PRESSURIZED
PRESS(psig) driver _____ gear _____ control _____
System Design _____ R.V. Set _____
SCHEMATIC DIAGRAM: _____
GPM: turb _____ gear _____ control oil _____
Driven Equipment _____
MAIN PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver _____ hp _____
Coupling _____
Location _____ Control _____
AUX. PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver _____ hp _____
Coupling _____
Location _____ Control _____
COOLER: no. _____ make _____ location _____
Duty _____ Surface _____ Water (gpm) _____
Shell: o.d. _____ thickness _____ des. press. _____
Tubes: o.d. _____ length _____ bwg _____ no. _____
Material: shell _____ channel _____ tubes _____
Switch Valve: make _____ mat'l. _____
FILTERS: no _____ make _____ type _____
Casing Mat'l. _____ Flanges _____
Design Press _____ Δ P _____ Micron _____
Switch Valve: make _____ mat'l. _____
RESERVIOR: location _____ size _____
Retention _____ Material _____
Flanges _____ Interior Coating _____
Heating Coil _____
Insulation Supports _____

NET WEIGHT _____ SHIPPING WEIGHT _____

INSPECTION & TESTS

Item	Required Yes	Required No	Witnessed Yes	Witnessed No
Shop Inspection	☒	☐	☒	☐
Mechanical Run	☒	☐	☒	☐
Performance	☐	☒	☐	☐
Bearings (Post Run)	☒	☐	☒	☐
Auxiliary Equipment	☐	☐	☐	☐
With Gear		☒		☐
Hydrostatic	☒	☐	☒	☐
Other	☐	☐	☐	☐

Comments: _____

INSTRUMENTATION

CONTROL PANEL: NO furnished by _____

INSTRUMENTS	MAKE	SIZE	LOCATION
STEAM INLET PG	VALVED & PLUG		(5)
STEAM CHEST PG	VALVED & PLUG		(3)
1st STAGE STEAM PG			
EXHAUST STEAM PG	VALVED & PLUG		(5)
L.O. PRESS at PUMP			
L.O. PRESS at BRGS			
OIL FILT. PG & MANIFOLD			
BRG. TEMP.	5" DIAL THERM		EACH DRAIN (3)
L.O. to COOLER			
L.O. from COOLER			
C.W. to OIL COOLER			
C.W. from OIL COOLER			
G.G. L.O. RESER.			
FLOW INDICATOR	IN EA. BRNG DRAIN		
LOW L.O. PRESS. ALARM			
AUX. L.O. PUMP RUN ALARM			
THROTTLE VA. TRIP ALARM			

TACHOMETER: vibrating reed NO electrical YES
SPEED TRANSMITTER: ~~NO~~ , type PICKUP ONLY READ-OUT BY CELANESE

CODES

TURBINES: API 611 ELEC: _____ class I group D div 2
PIPING: ANSI B31.3 VESSELS: — EXCHANGERS: —
GEAR: API 613

ALLOWABLE PIPING FORCES & MOMENTS

	INLET FLANGE Force lb.	INLET FLANGE Moment ft.-lb.	EXHAUST FLANGE Force lb.	EXHAUST FLANGE Moment ft. lb.	
PARALLEL TO SHAFT					*
VERTICAL					*
HORIZ. 90° TO SHAFT					*

UTILITIES

STEAM AUX: inlet _____ psig _____ Ftt EXH _____ psig/in Hg abs
ELECTRICAL POWER: 460 v 3 ph 60 cy
CONTROL: 120 v 1 ph 60 cy
COOLING WATER: temp 90 F-Press 50 psig
INSTRUMENT AIR (psig): 90 SERVICE AIR (psig): 90

EXCEPTIONS TO SPECIFICATIONS

ITEMS MARKED * TO BE COMPLETED BY TURBODYNE AND RETURNED.
(1) TURBODYNE TO FURNISH AIRPAX SENSOR. PURCH. TO FURNISH MONITOR AND INSTALL REMOTE.
(2) WATER COOLED BEARING HOUSING TO BE PLUGGED

NOTES:
(3) Turbine to meet Purchaser's General Purpose Steam Turbine Specifications S-50.03-01.
(4) RATED + NORMAL PER TO API 611 PARA 9A.4.B
INSULATION CLIPS REQUIRED.
NO POSITIONING SCREWS REQ'D FOR SOLE PLATE

V.O.B. 12-27
BY CHK'D. DATE
ORIGINAL Y CHKD APPVD

BROWN & ROOT Inc. HOUSTON, TEXAS

CONT NO ER-0995

SPEC NO 149-M-14-DS

STEAM TURBINE DATA SHEET FOR PT-1223

TURBINE TO MEET GENERAL PURCHASERS' SPECIFICATION S-50.03-01

BY JHK 1/17/74 REVIEWED APPROVED BCS DATE 11-13 SHT 1 OF 2

CLIENT CELANESE CHEMICAL CO
DESTINATION BISHOP TEXAS
UNIT STEAM TURBINE, I.D. FAN
ITEM PT 1223 NO. REQ'D ONE JOB NO. ER-0995
DRIVEN EQUIPMENT INDUCED DRAFT FAN THRU GEAR REDUCER

OPERATING CONDITIONS

ITEM-COND:	RATED	DESIGN	NORMAL	MINIMUM
HORSEPOWER:	1118		732	
SPEED (rpm):	4760		4025	
INITIAL PRESS (psig)	600	650	600	600
INITIAL TEMP (Ftt):	750	750	750	750
EXH PRESS (psig/in.Hg.abs):	55	55	50	40
EXH TEMP (Ftt):	SAT		SAT.	SAT.
* HAND VALVES OPEN:				
* WATER RATE:				

MAX.CASING PRESSURE (psig) 650
MAX.ALLOW.PRESS.EXH.END (psig) 75
INDOOR ____ OUTDOOR X ROOF: ~~Yes~~ - No
WINTERIZATION: ~~Yes~~ - No
DUTY: cont. V intermit ____ stand by ____ hrs/yr 8760
STEAM COST: $/M# ____ PAYOUT PERIOD (yrs) ____

CONSTRUCTION FEATURES

TYPE: vert ____ horiz. X NO.STAGES: single X mult ____
ROTATION (from gov end): cw ____ (ccw) YES
GOVERNOR: mech ____ hydr ____ oil relay ____ NEMA class D
CONTROL: WOODWARD PG-PL

GOVERNOR VALVE TYPE: single X mult —
AIR HEAD FOR INSTRUMENT CONTROL YES JACK SCREW —
Range 40 % below 4760 rpm
Max. rpm @ 5000 AT 15 psig Min rpm @ 2850 AT 3 psig
HAND SPEED CHANGER: range 5000 max rpm 2850 min rpm
TRIP-THROTTLE VALVE: separate COMBINED
Remote trip YES - SOLENOID Actuation DE-ENERGIZED
Other trip LOCAL Actuation MANUAL
Other trip EMERGENCY Actuation MECH GOV.
SOLE PLATE YES BASE PLATE ____ FURNISHED BY VENDOR
Turbine V Turbine & Gear NO Driven Eqpt. NO
STEAM INLET: rating 600 facing RF orient RT-UP
EXHAUST: rating 150 facing RF orient LFT SIDE

* DRAINS:	no. ____	type & size ____	
* VENTS:	no. ____	type & size ____	
* WATER CONN:	no. ____	type & size ____	
* LUBE OIL INLET:	no. ____	type & size ____	
* LUBE OIL OUTLET:	no. ____	type & size ____	
* SEAL STEAM CONN:	no. ____	type & size ____	
* GLAND DRAIN CONN:	no. ____	type & size ____	
* INSTRUMENT CONN:	no. ____	type & size ____	
* OTHER CONN: service	____		
type & size	____		

MANUFACTURER TURBODYNE
TYPE & SIZE 283 WVK
SERIAL NO. ____
QUOTE NO. 30-216-74 DATE 7/5/74
PURCHASE ORDER NO. 50022 DATE ____

CONSTRUCTION FEATURES (cont.)

COUPLING: make BY GEAR VENDOR type ____
Mount Coupling Half: (Yes) No
Lubrication: ____ Mounting: NEMA TAPER
Furnished by: GEAR VENDOR
INSULATION: Yes (No) ~~type~~ STUDS TO BE FURNISHED
JACKET: Yes (No) type ____
GEAR UNIT: required YES type SINGLE HELICAL
↑ BY PURCHASER

TURBINE SPECIFICATIONS

NO. OF STAGES ONE
ROTOR TYPE: solid ____ built up V
SPEED (rpm): max.allow 5000 1st crit * trip 5500
NO.AUTO VALVES: ____ TYPE LIFT: cam — bar —
BEARINGS: radial type & size SPLIT SLEEVE JOURNAL
THRUST: type & size TILT PAD THRUST
PACKING TYPE: end glands CARBON RING
Interstage Diaphragms NONE

MATERIALS:
Steam Inlet Parts CARBON STEEL
Casing ____ Shaft ____
Nozzles ____ Nozzle Rings ____
Wheels ____ Blading ____
Shrouds ____ Gov. Trim Valve ____
Labyrinths ____
Shaft Material Under Packing ____
Applied By: spraying ____ plating ____
NET WEIGHT: ____ SHIPPING WEIGHT: ____
ROTOR WEIGHT: ____
WEIGHT HEAVIEST PIECE FOR MAINT: ____

GEAR SPECIFICATIONS

MANUFACTURER ____ DESIGNATION ____
BUILT IN ____ SEPARATE ____
NO.OF REDUCTIONS ____ RATIO ____
CL. to CL. OF SHAFTS ____ FACE WIDTH ____
TYPE OF BEARINGS ____ TYPE LUBR ____
AGMA GEAR: service factor ____ type ____
ROTATION L.S. (from gov end): cw ____ ccw ____
SPEED OF L.S. (rmp): ____
LUBRICATION: ____
NET WEIGHT: ____ SHIPPING WEIGHT: ____
WEIGHT HEAVIEST PIECE FOR MAINT: ____
MATERIALS:
Case ____ Shaft ____
Case ____ Pinion ____
Brgs ____

CHKD. DATE
MCS 12-2774
11-5-74 11-13

BROWN & ROOT, Inc. HOUSTON, TEXAS

BROWN-BILT

ER-0995 REV.
149-M-14 -DS
SHT 2 OF 2

Item PT=1223

GEAR SPECIFICATIONS (cont.)

COUPLING: make _____ type _____
Mount Coupling Half: _____ Yes - No
Lubrication: _____ Mounting: _____
Furnished by: _____

LUBE OIL SYSTEM

TYPE: BY OTHERS - PRESSURIZED
PRESS(psig) driver _____ gear _____ control _____
System Design _____ R.V. Set _____
SCHEMATIC DIAGRAM: _____
GPM: turb _____ gear _____ control oil _____
Driven Equipment _____
MAIN PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver _____ hp _____
Coupling _____
Location _____ Control _____
AUX.PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver _____ hp _____
Coupling _____
Location _____ Control _____
COOLER: no _____ make _____ location _____
Duty _____ Surface _____ Water (gpm) _____
Shell: o.d. _____ thickness _____ des.press. _____
Tubes: o.d. _____ length _____ bwg _____ no. _____
Material: shell _____ channel _____ tubes _____
Switch Valve: make _____ mat'l. _____
FILTERS: no _____ make _____ type _____
Casing Mat'l. _____ Flanges _____
Design Press _____ Δ P _____ Micron _____
Switch Valve: make _____ mat'l. _____
RESERVIOR: location _____ size _____
Retention _____ Material _____
Flanges _____ Interior Coating _____
Heating Coil _____
Insulation Supports _____

NET WEIGHT _____ SHIPPING WEIGHT _____

INSPECTION & TESTS

Item	Required Yes	Required No	Witnessed Yes	Witnessed No
Shop Inspection	☒	☐	☒	☐
Mechanical Run	☒	☐	☒	☐
Performance	☐	☒	☐	☐
Bearings (Post Run)	☒	☐	☒	☐
Auxiliary Equipment	☐	☐	☐	☐
With Gear		☒		☒
Hydrostatic	☒	☐	☒	☐
Other	☐	☐	☐	☐

Comments: 6. SPEC. S50.12-01 DOES NOT APPLY

VOID SEE SHEET 11-13-79 JEE-29-79

BY CHK'D. DATE

CHKD APPVD

INSTRUMENTATION

CONTROL PANEL Yes NO furnished by _____

INSTRUMENTS	MAKE	SIZE	LOCATION
STEAM INLET PG	VALVE & PLUG		(5)
STEAM CHEST PG	VALVE & PLUG		(3)
1st STAGE STEAM PG			
EXHAUST STEAM PG	VALVE & PLUG		(3)
L.O. PRESS at PUMP			
L.O. PRESS at BRGS			
OIL FILT. PG & MANIFOLD			
BRG. TEMP.	5" DIAL THERM.	EACH DRAIN	(3)
L.O. to COOLER			
L.O. from COOLER			
C.W. to OIL COOLER			
C.W. from OIL COOLER			
G.G. L.O. RESER.			
FLOW INDICATOR	IN EACH BRNG DRAIN		
LOW L.O. PRESS. ALARM			
AUX. L.O. PUMP RUN ALARM			
THROTTLE VA. TRIP ALARM			

TACHOMETER: vibrating reed NO electrical YES (1)
SPEED TRANSMITTER: Yes - Not (1) type PICKUP ONLY READ-OUT BY CELANESE

CODES

TURBINES: API 611 ELEC: _____ class 1 group D div 2
PIPING: B31.3 VESSELS: —— EXCHANGERS: ——
GEAR: API 613

ALLOWABLE PIPING FORCES & MOMENTS

	INLET FLANGE Force lb.	INLET FLANGE Moment ft.-lb.	EXHAUST FLANGE Force lb.	EXHAUST FLANGE Moment ft.-lb.	
PARALLEL TO SHAFT					*
VERTICAL					*
HORIZ. 90° TO SHAFT					*

UTILITIES

STEAM AUX: inlet _____ psig _____ Ftt EXH ____ psig/in Hg abs
ELECTRICAL POWER: 460 v 3 ph 60 cy
CONTROL: 120 v 1 ph 60 cy
COOLING WATER: temp 90 F-Press 50 psig
INSTRUMENT AIR (psig) 90 SERVICE AIR (psig): 90

EXCEPTIONS TO SPECIFICATIONS

ITEMS MARKED * TO BE COMPLETED BY TURBODYNE AND RETURNED
(1) TURBODYNE TO FURNISH AIRPAX SENSOR. PURCH. TO FURNISH MONITOR AND INSTALL REMOTE.
(2) WATER COOLED BRNG HOUSING TO BE PLUGGED
NOTES:
(3) Turbine to meet purchaser's General Purpose Steam Turbine Specification S-50.03-01.
(4) RATED AND NORMAL REFER TO API 611 PARA 4A + 4B. 5. INSULATION STUDS ARE REQD. NO POSITIONING SCREWS REQUIRED FOR SOLEPLATE.

BROWN & ROOT Inc. HOUSTON, TEXAS	CONT NO ER-0775
STEAM TURBINE DATA SHEET ITEM NOS. PT 1226/1227	SPEC NO 147-M-14
BY JHK 7/27/74 REVIEWED WHS APPROVED BAS DATE 11-13	SHT. 1 OF 3

CLIENT CELANESE CHEMICAL CO.
DESTINATION BISHOP, TEXAS
UNIT METHANOL
ITEM PT1226/1227 NO REQ'D. 2 JOB NO. ER-0775
DRIVEN EQUIPMENT BOILER FEEDWATER PUMPS
(P-2488/2489)

OPERATING CONDITIONS

ITEM-COND:	** RATED	DESIGN	NORMAL**	MINIMUM
HORSEPOWER:	619		526	
SPEED (rpm):	3600		3450	
INITIAL PRESS (psig)	240	250	240	240
INITIAL TEMP (Ftt):	SAT	SAT	SAT.	SAT.
EXH PRESS (psig/in.Hg.abs):	55	55	50	40
EXH TEMP (Ftt):	SAT	SAT	SAT.	SAT.
* HAND VALVES OPEN:	2		1	
* WATER RATE:				

MAX.CASING PRESSURE (psig) 250 INLET END
MAX.ALLOW.PRESS.EXH.END (psig) 75
INDOOR — OUTDOOR ✓ ROOF: — No
WINTERIZATION: No
DUTY:cont. ✓ intermit — stand by — hrs/yr 8760
STEAM COST:$/M# PAYOUT PERIOD (yrs)

CONSTRUCTION FEATURES

TYPE:vert — horiz. ✓ NO.STAGES:single ✓ mult —
ROTATION(from gov end):cw — ccw CCW
GOVERNOR:mech — hydr — oil relay ✓ NEMA class D
CONTROL: WOODWARD PG-PL
(PRESSURE CONTROL)
GOVERNOR VALVE TYPE:single ✓ mult —
AIR HEAD FOR INSTRUMENT CONTROL YES JACK SCREW —
Range 25% % below 3600 rpm
Max. rpm @ 3780 @ 15 psig-Min rpm @ 2700 @ 3 psig
HAND SPEED CHANGER:range 3780 max rpm 2700 min rpm
TRIP-THROTTLE VALVE: ~~separate~~ COMBINED
Remote trip YES Actuation ENERGIZE
Other trip LOCAL Actuation MANUAL
Other trip EMERGENCY Actuation MECH. GOV.
SOLE PLATE BASE PLATE ✓ FURNISHED BY TURBO.
Turbine ✓ Turbine & Gear — Driven Eqpt. ✓
STEAM INLET:rating 600 # facing R.F. orient RT./UP
EXHAUST: rating 150 # facing R.F. orient LEFT/SIDE
* DRAINS: no. type & size
* VENTS: no type & size
* WATER CONN: no. type & size
* LUBE OIL INLET: no. type & size
* LUBE OIL OUTLET no. type & size
* SEAL STEAM CONN: no. type & size
* GLAND DRAIN CONN: no. type & size
* INSTRUMENT CONN: no. type & size
* OTHER CONN:service
type & size

MANUFACTURER TURBODYNE
TYPE & SIZE 232 WHB
SERIAL NO. *
QUOTE NO. 30-216-74 DATE 7/5/74
PURCHASE ORDER NO. 2 DATE
040-041-50022

CONSTRUCTION FEATURES (cont.)

COUPLING:make METASTREAM type FLEX-SPACER
Mount Coupling Half: Yes STRAIGHT BORE-SINGLE KEY
Lubrication: NO Mounting BY TURBODYNE
Furnished by: PUMP VENDOR
INSULATION: No type TURBODYNE TO FURNISH INSULATION CLIPS
JACKET: No type
GEAR UNIT:required NO type —
Coupling Guard by Turbo.

TURBINE SPECIFICATIONS

NO. OF STAGES SINGLE
ROTOR TYPE:solid — built up ✓
SPEED(rpm):max.allow 1st crit trip *
NO.AUTO VALVES: TYPE LIFT:cam — bar —
BEARINGS:radial type & size SLEEVE
THRUST:type & size BALL
PACKING TYPE:end glands CARBON RING
Interstage Diaphragms NONE
MATERIALS:
Steam Inlet Parts CAST STEEL-TBD CL.II
Casing ASTM A216 WCB Shaft HOT ROLLED ALLOY
Nozzles S.S. Nozzle Rings S.S.
Wheels CARBON STEEL Blading S.S.
Shrouds S.S. Gov. Trim Valve S.S.
Labyrinths NONE
Shaft Material Under Packing 12 CR. SS
Applied By:spraying ✓ plating —
NET WEIGHT: SHIPPING WEIGHT: *
ROTOR WEIGHT: *
WEIGHT HEAVIEST PIECE FOR MAINT: *

GEAR SPECIFICATIONS

MANUFACTURER DESIGNATION
BUILT IN SEPARATE
NO.OF REDUCTIONS RATIO
CL. to CL. OF SHAFTS FACE WIDTH
TYPE OF BEARINGS TYPE LUBR
AGMA GEAR:service factor type
ROTATION L.S.(from gov end):cw ccw
SPEED OF L.S.(rmp):
LUBRICATION:
NET WEIGHT: SHIPPING WEIGHT:
WEIGHT HEAVIEST PIECE FOR MAINT:
MATERIALS:
Case Shaft
Case Pinion
Brgs

** SEE NOTE 5

CHKD. DATE APP.
BAS 11-13 JHK 12-27

BROWN & ROOT, Inc. HOUSTON, TEXAS

EIC-0795
149-M-1A REV.

SHT 2 OF 3

ITEMS PT-1226 & 1227

GEAR SPECIFICATIONS (cont.)

COUPLING: make _____ type _____
Mount Coupling Half: _____ Yes - No
Lubrication: _____ Mounting: _____
Furnished by: _____

LUBE OIL SYSTEM

TYPE: PRESSURIZED
PRESS(psig) driver _____ gear _____ control _____
System Design _____ R.V. Set _____
SCHEMATIC DIAGRAM: SEE PAGE 3 of SPEC
GPM turb _____ gear _____ control oil _____
Driven Equipment _____
MAIN PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver SHAFT hp _____
Coupling _____
Location _____ Control _____
AUX.PUMP: make _____ type _____
Casing Mat'l. _____ Flanges _____
Speed _____ gpm _____
Driver ELECTRIC hp _____
Coupling _____
Location _____ Control _____
COOLER: no. 1 make _____ location _____
Duty _____ Surface _____ Water (gpm) _____
Shell: o.d. _____ thickness _____ des.press. _____
Tubes: o.d. 5/8" length _____ bwg _____ no. _____
Material: shell _____ channel _____ tubes INHIB ADM
Switch Valve: make — mat'l. — type —
FILTERS: no 2 make _____ type CARTRIDGE
Casing Mat'l. _____ Flanges _____
Design Press _____ Δ P 5 PSIG CLEAN Micron 25
Switch Valve: make _____ mat'l. _____
RESERVIOR: location _____ size _____
Retention 5 MIN. Based on System Req.
Flanges _____ Interior Coating _____
Heating Coil _____
Insulation Supports _____
SIGHT GLASS
NET WEIGHT _____ SHIPPING WEIGHT _____

INSPECTION & TESTS

Item	Required Yes	Required No	Witnessed Yes	Witnessed No
Shop Inspection	☒	☐	☒	☐
Mechanical Run	☒	☐	☒	☐
Performance	☐	☒	☐	☐
Bearings (Post Run)	☒	☐	☒	☐
Auxiliary Equipment	☐	☐	☐	☐
With Gear	☐	☐	☐	☐
Hydrostatic	☒	☐	☒	☐
Other	☐	☐	☐	☐

Comments: _____

INSTRUMENTATION

CONTROL PANEL Yes - No furnished by _____

INSTRUMENTS	MAKE	SIZE	LOCATION
STEAM INLET PG	VALVE + PLUG		
STEAM CHEST PG	VALVE + PLUG		
1st STAGE STEAM PG			
EXHAUST STEAM PG	VALVE + PLUG		
L.O. PRESS at PUMP	VALVE + PLUG		
L.O. PRESS at BRGS	HEADER: VALVE + PLUG		
OIL FILT. PG & MANIFOLD	VALVED CONN BEFORE & AFTER		
BRG. TEMP	5" DIAL THERMOMETER		IN EA DRAIN
L.O. to COOLER	" "		"
L.O. from COOLER	" "		"
C.W. to OIL COOLER	NO	—	—
C.W. from OIL COOLER	5" DIAL THERMOMETER		
G.G. L.O. RESER.	YES		
FLOW INDICATOR	IN EA. BRG DRAIN		
LOW L.O. PRESS. ALARM	YES		
AUX. L.O. PUMP RUN ALARM	YES OFF OF START SW.		
THROTTLE VA. TRIP ALARM	NO		
TACHOMETER: vibrating reed	NO	electrical	YES
SPEED TRANSMITTER	No	type	PICK UP ONLY READ OUT BY CENTRESE

CODES

TURBINES: API 611 ELEC NEMA class 1 group D div 2
PIPING: B31.3 VESSELS: — EXCHANGERS: —
GEAR: NONE

ALLOWABLE PIPING FORCES & MOMENTS

	INLET FLANGE Force lb	INLET FLANGE Moment ft.-lb.	EXHAUST FLANGE Force lb.	EXHAUST FLANGE Moment ft. lb.
PARALLEL TO SHAFT				
VERTICAL				
HORIZ. 90° TO SHAFT				

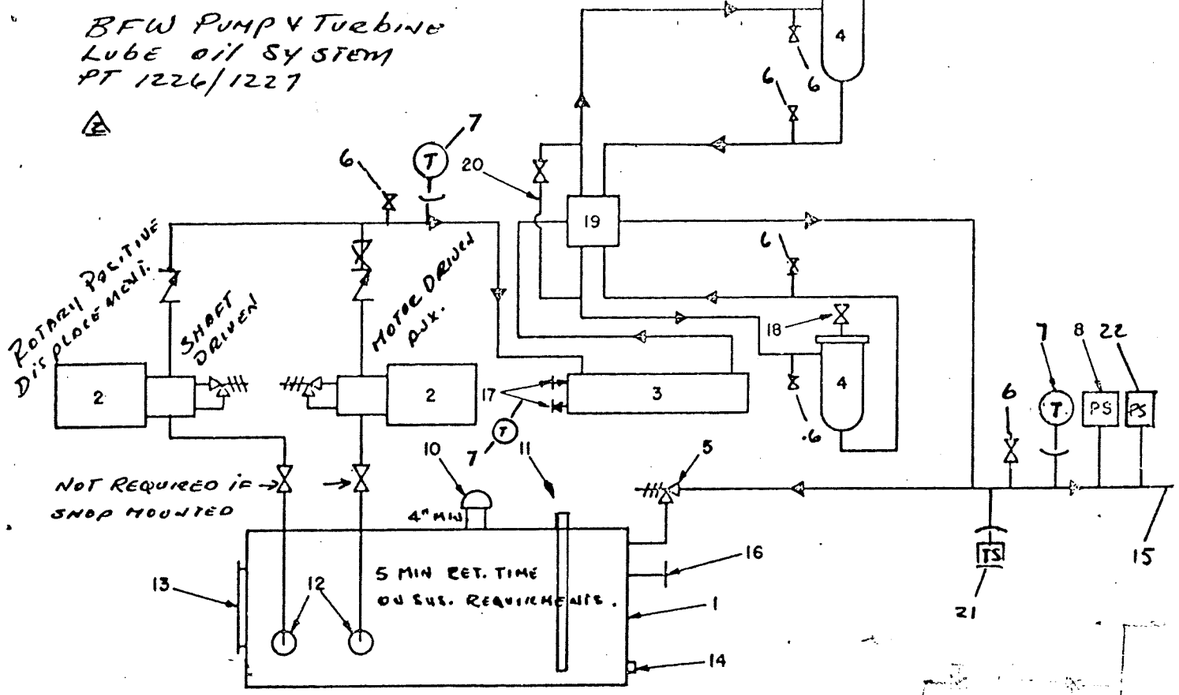
UTILITIES

STEAM AUX: inlet _____ psig _____ Ftt EXH ___ psig/in Hg abs
ELECTRICAL POWER: 460 v 3 ph 60 cy
CONTROL: 120 v 1 ph 60 cy
COOLING WATER: temp 90 F-Press 50 psig
INSTRUMENT AIR (psig): 90 SERVICE AIR (psig): 90

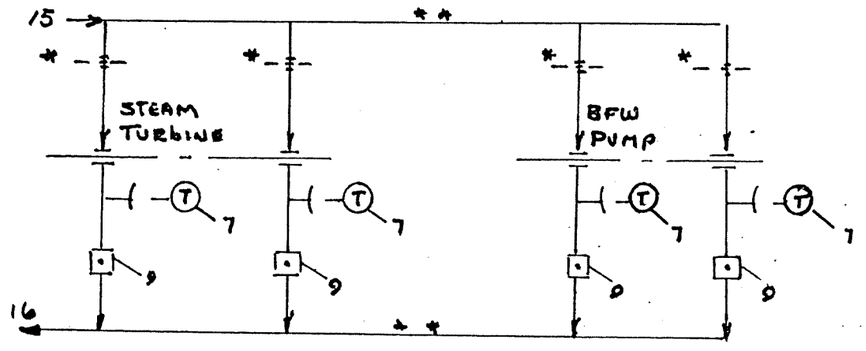
ADDITIONS AND COMMENTS
~~EXCEPTIONS~~ TO SPECIFICATIONS

(1) TURBINE FURN WITH LOW OIL PRESS TRIP AND
SOLENOID VALVE - STAINLESS STEEL NOZZLE RI
HIGH OIL TEMP & LOW LUBE OIL PRESS SD DPD
(2) TURBINE TO MEET PURCHASERS
SPEC. S-50.03-01
(3)
(4) TURBINE TO HAVE STAINLE
COOLED BEARING LINING SEGME
(5) RATED & NORMAL REFER TO API 61
PARAGRAPH 4.1.5.2
(6) SPEC SSD.12-01 DOES NOT APPLY
(7) LUBE OIL SYSTEM TO HAVE SUMMAT
TO FURNISH THE COOLER PERFORMANCE

BFW PUMP & TURBINE
LUBE OIL SYSTEM
PT 1226/1227



1. Reservoir
2. Pump and Driver Assembly
3. Cooler 5/8" INHIB ADM. TUBES
4. Filter TWIN, 25 MICRONS
5. Pressure Regulating Valve FULL FLOW, SELF CONTAINED
6. VALVE W PLUGGED PRESSURE TAPS.
7. Temperature Gauge 5" DIAL
8. Pressure Switch LOW OIL ALARM; AUX PUMP START;
9. SIGHT FLOW INDICATOR
10. Fill and Vent Breather Cap
11. Sight Level Gauge
12. Pump Suction Screen
13. Cleanout Opening
14. Drain
15. Oil Supply Connection
16. Oil Return Drain Connection
17. Cooling Water Connections
18. Vent Cock
19. Transfer Valve
20. Pressure Equalization Line
21. TEMP SWITCH - HIGH TEMP ALARM
22. LOW OIL P.S - SHUT DOWN



NOTE:

* 1. ORFICE IF REQUIRED.
2. STAINLESS STEEL LUBE OIL PIPING.
** 3. LUBE OIL PIPING TO BFW PUMP TO BE SHIPPED LOOSE by TURBODYNE.
4. BFW OIL REQUIREMENTS: 46PH @ 5 PSIG.
5. SKID MOUNTED LUBE CONSOLE

202 W4B
240 PSIG - 403° - 50 PSIG
295 HP @ 4120 RPM (440 HP @ 4760 RPM - RATED)
@ 555 PSIG

FINAL ISSUE
APPROVED BY
Borotenco
DAVY POWERGAS INC.

VENDOR TO PROVIDE WATER RATE DATA

STEAM FLOW - LBS/HR

24000
20000
16000
12000
8000

H.V. #1 OPEN
ALL H.V.'s CLOSED

0
100
200
300
400

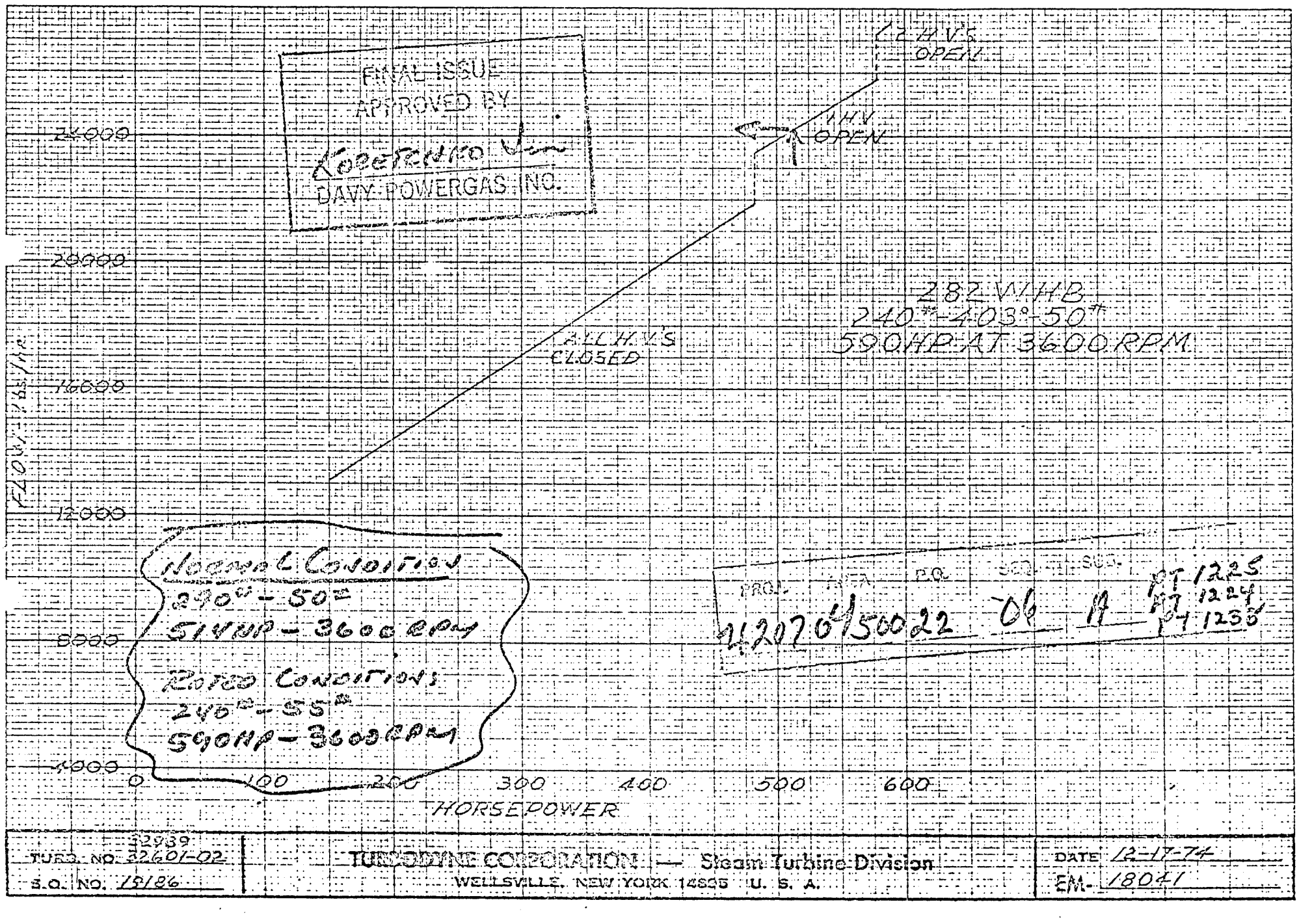
HORSEPOWER

H207 A50022 05 A PT1222

TURBODYNE CORPORATION
WORTHINGTON TURBINE DIVISION
WELLSVILLE, NEW YORK U.S.A.

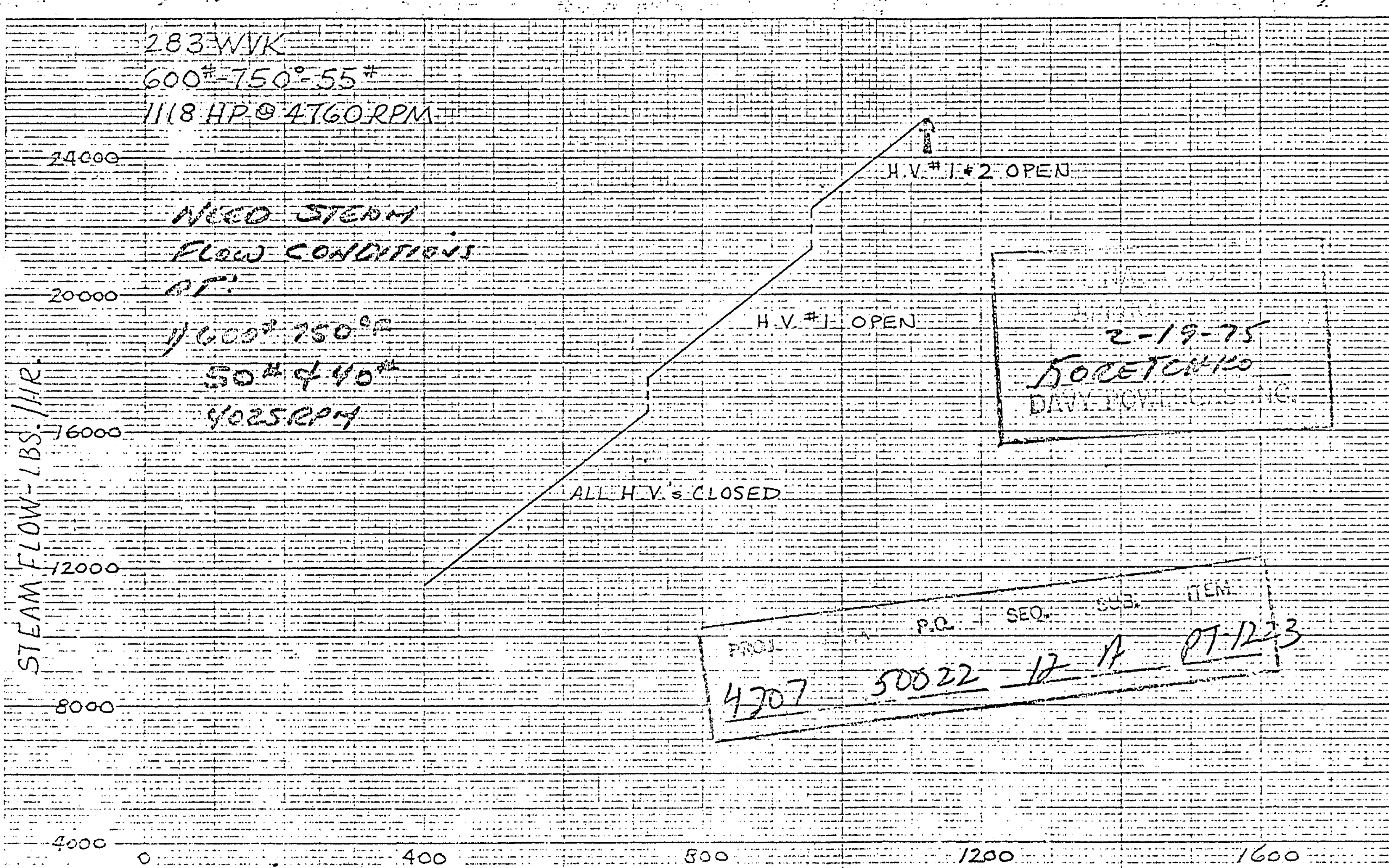
TURB. NO. 22600
SO. NO. 19185

DATE 12-16-74
EM-18038



TURB. NO. 32939 32601-02	TURBODYNE CORPORATION — Steam Turbine Division	DATE 12-17-74
S.O. NO. 19186	WELLSVILLE, NEW YORK 14895 U. S. A.	EM- 18041

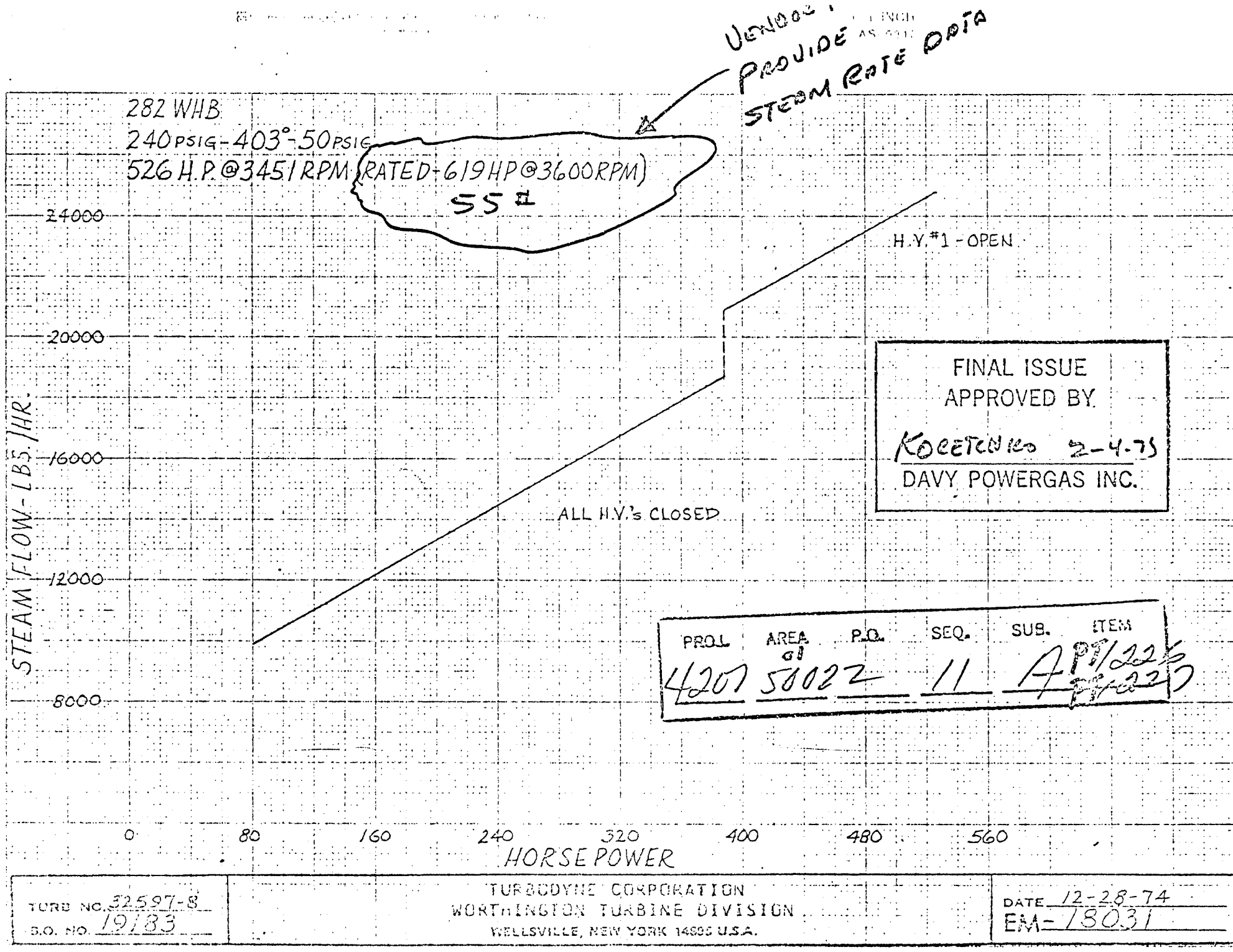
SQUARE 20 × 20 1 INCH
AS-0810-01



TURB. NO. 32599
S.O. NO. 19184

TURBODYNE CORPORATION
WORTHINGTON TURBINE DIVISION
WELLSVILLE, NEW YORK 14895 U.S.A.

DATE 1-27-75
EM-18081



FINAL ISSUE
APPROVED BY
KOCETON 2-4-75
DAVY POWERGAS INC.

PROJ.	AREA	P.O.	SEQ.	SUB.	ITEM
4201	58022		11		4P1/22 thru 22D

TURB NO. 32597-8
S.O. NO. 19183

TURBODYNE CORPORATION
WORTHINGTON TURBINE DIVISION
WELLSVILLE, NEW YORK 14895 U.S.A.

DATE 12-28-74
EM- 18031

SQUARE 25 × 25 1 INCH
AS-0810 5

202WHB
250#+40G#-55#
440 HP @ 4760 RPM

NOTE
STILL NEED
STEAM FLOW
240# — 40#
240 - 50#
240 - 55#

CORRECTED 2-13-75
DAVY POWERGAS INC.

H.V.#3 1/2 OPEN
H.V.#1 OPEN
ALL H.V.'s CLOSED

STEAM FLOW-1000 LBS/HR
25000
20000
15000
10000
5000
0

100 200 300 400 500
HORSEPOWER

FROM
4207 50022 13 A PT1222

FEB. 13, 75
DPI-18022

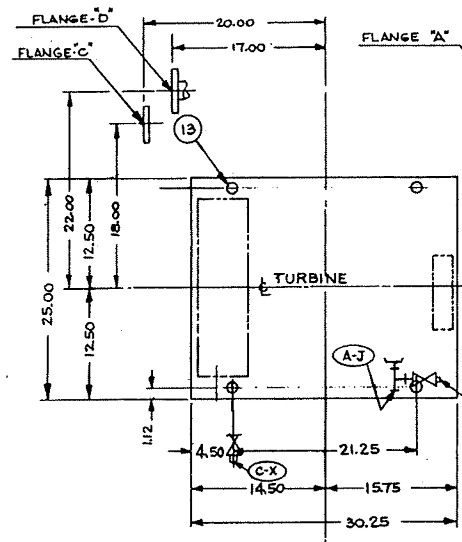
LD-143912 (REF. LD-136721, LD-126117, LD-137270, LC-136377)

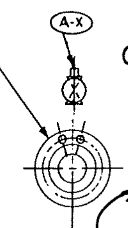
"SST" LINE STEAM TURBINE
WITH WOODWARD (PG-PL) DIRECT-ACTING (HS) GOVERNOR

440 HP. FRAME 202 WHB 4760 RPM.

APPROXIMATE WEIGHTS

TURBINE	2000 LBS
SOLEPLATE	275 LBS
APPROX. WEIGHT	2275 LBS
UPPER HALF OF TURBINE CASING	250 LBS
TURBINE ROTOR	235 LBS





16. GOVERNOR SETTINGS:
 3# - 2850 R.P.M. TURBINE SPEED.
 15# - 5000 R.P.M TURBINE SPEED.

18. COUPLING NUT SUPPLIED BY WORTHINGTON.

(17) ?

20. LAGGING HOOKS ON TURBINE CASING.
21. USE DRY AIR OR INERT GASES FOR PURGING GOVERNOR - PURGING PRESSURE SHOULD BE SLIGHTLY OVER ATMOSPHERIC PRESSURE.
22. SOLENOID DUMP VALVE 1PH.-60HZ 120VA LOCATED IN LOW OIL PRESSURE TRIP LINE TO TRIP WHEN DE-ENERGIZED.
23. TACHOMETER MAGNETIC PICKUP AIRPAX. #1-0005 WITH 60TOOTH GEAR ON TURBINE SHAFT.

SEND DETAIL SPEC. OR DWG.

(22) B-T

— MAX ALLOWABLE EXH END PRESSURE?
— NEED DIAGRAMMATIC DWG OF OIL SYSTEM
— THERMAL EXPANSION INFORMATION? TO BE SENT TO PHIL GEAR AND BENDIX. NEED CONFIRMATION INFORMATION HAS BEEN SENT.

NOTES:

1. STEAM INLET & EXHAUST PIPING MUST BE PROPERLY SUPPORTED SO AS NOT TO EXCEED ALLOWABLE FORCES & MOMENTS.
2. FOUNDATION BOLTS SHOULD NOT BE RIGIDLY LOCATED UNTIL UNIT IS IN PLACE ON FOUNDATION AS BOLT HOLES IN SOLE PLATE MAY VARY .25
3. HAND SPEED ADJUSTMENT KNOB. MUST BE BACKED OUT AND LOCKED DURING AUTOMATIC SPEED CONTROL.
4. AN ATMOSPHERIC RELIEF VALVE OF SUFFICIENT SIZE TO PASS 23,582 LBS. PER HOUR WITH A MAXIMUM PRESSURE OF 145 LBS. P.S.I.G. AND SET TO OPEN AT 130 LBS. P.S.I.G. SHOULD BE PLACED IN THIS LINE. NO SHUT OFF VALVE SHOULD BE PLACED BETWEEN RELIEF VALVE AND TURBINE.
5. VENT SCREW - LOOSEN TO ALLOW AIR TO BLEED FROM GOVERNOR HYDRAULIC SYSTEM WHEN FIRST PUT INTO SERVICE OR IF GOVERNOR HAS BEEN TAKEN DOWN, DRAINED AND REFILLED.
6. ? EYEBOLT IN TURBINE CASE COVER TO BE USED FOR LIFTING TURBINE CASE COVER ONLY.
7. BOLT HOLES IN FLANGES TO STRADDLE HORIZONTAL AND VERTICAL CENTERLINES.
8. SENTINEL WARNING VALVE. *SETTING?*
9. SHIMS FURNISHED BY ~~OTHERS~~. *Turbodyne*
10. ? HAND VALVES - 2 - REQUIRED.
11. ? LOW OIL PRESSURE TRIP.
12. 1-KEYWAY - SEE DETAIL OF SHAFT END
13. 4-HOLES - 1⅛ DIA. DRILL THRU FOR 1IN FOUNDATION BOLTS (SEE NOTE #2)
14. HIGH SPEED STOP OVERRIDE DEVICE.
15. EXHAUST FLANGE STUDS FURNISHED BY TURBODYNE.

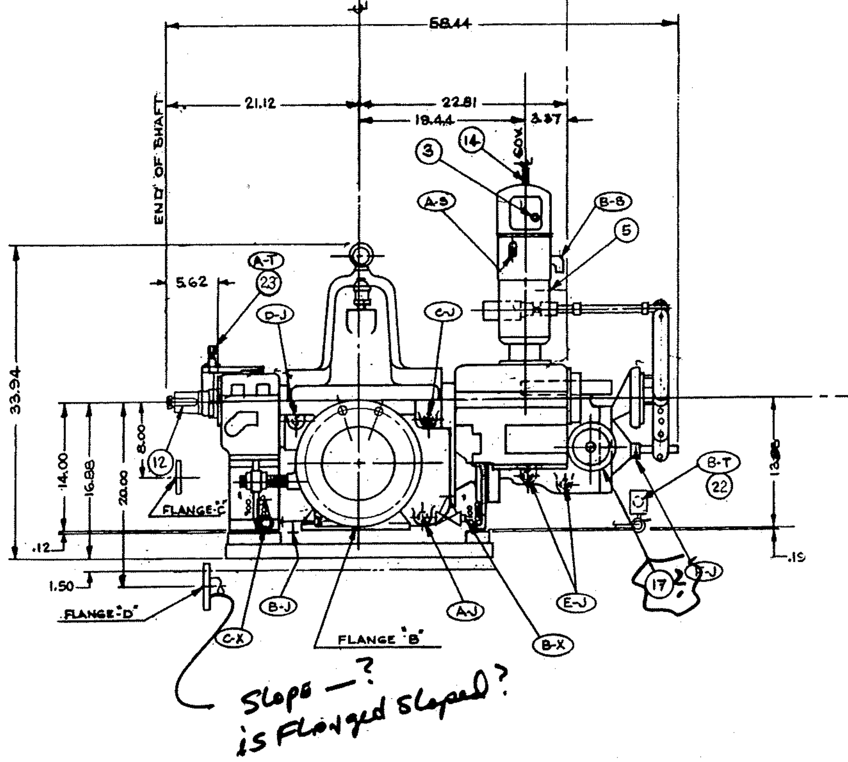
CUSTOMER'S FLANGED CONNECTIONS

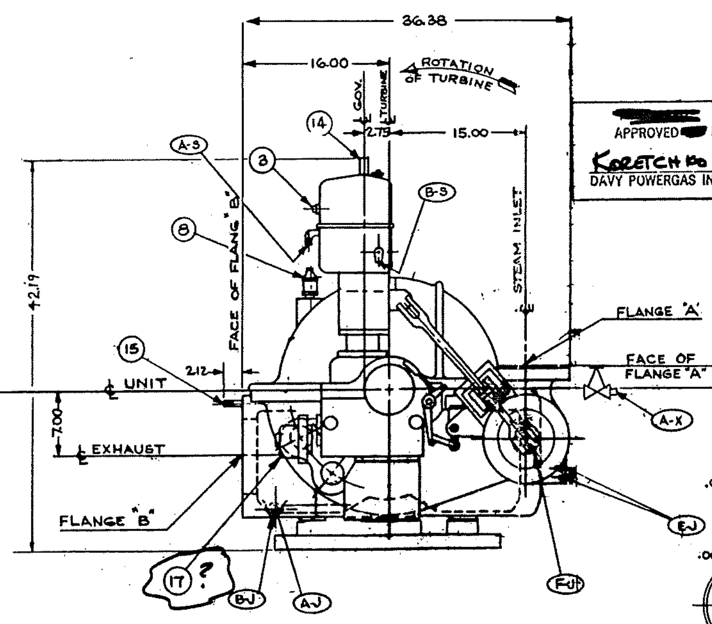
	FLANGE	U.S.A.S.I.	SIZE	O.D.	B.C.	NO. HOLES	DIA. HOLES	MIN. FLANGE THICKNESS	RAISED FACE	REMARKS
A	TURBINE INLET	600	4	10.75	8.50	8	1IN	1.50	.25x6.19 DIA.	NOTE #1
B	TURBINE EXHAUST	150	8	13.50	11.75	8	¾-10 TAP	—	NONE	NOTES #1 & #4
C	LUBE OIL SUPPLY	150	¾	3.87	2.75	4	⅝	.50	NONE	
D	LUBE OIL DRAIN	150	1½	5.00	3.87	4	⅝	.68	NONE	

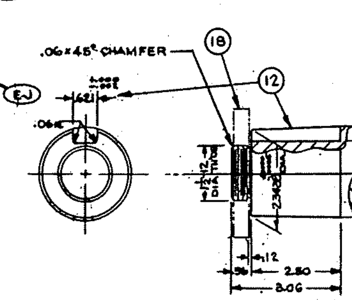
CUSTOMER'S SCREWED CONNECTIONS

	CONNECTION	NO.	SIZE	VALVE REQ'D	VALVE SUPPLIED BY	PIPE TO	REMARKS
A-J	STEAM RING DRAIN	1	¾ PIPE TAP	YES	CUSTOMER	OPEN DRAIN	
B-J	TURBINE CASING DRAIN	1	¾ PIPE TAP	YES	CUSTOMER	OPEN DRAIN	
C-J	STEAM END PACKING CASE DRAIN	1	½ PIPE TAP	NO		OPEN DRAIN	
D-J	EXHAUST END PACKING CASE DRAIN	1	½ PIPE TAP	NO		OPEN DRAIN	
E-J	STEAM CHEST DRAINS	2	¾ PIPE TAP	YES	CUSTOMER	OPEN DRAIN	
F-J	STEAM CHEST COVER DRAIN	1	½ PIPE TAP	NO		OPEN DRAIN	
A-T	TACHOMETER MAGNETIC PICKUP CONDUIT	1	½ PIPE TAP				NOTE #19
A-S	PNEUMATIC SPEED CONTROL	1	¼ S.A.E. TUBING			CUSTOMER'S AIR SUPPLY	NOTE #16
B-S	GOVERNOR PURGE AIR	1	¼ S.A.E. TUBING				NOTE #21
B-T	SOLENOID DUMP VALVE COND. CONN.	1	¾ PIPE TAP				NOTE #22
A-X	INITIAL GAUGE CONN.	1	¾ PIPE TAP	YES	TURBODYNE		
B-X	STEAM RING GAUGE CONN.	1	¾ PIPE TAP	YES	TURBODYNE		
C-X	EXHAUST GAUGE CONN.	1	¾ PIPE TAP	YES	TURBODYNE		

[redacted] APPROVED [redacted] AS NOTED
Koretch 3-9-75
DAVY POWERGAS INC.







SHAFT END DETAIL
SCALE: 6.00=12.00

PROJ.	AREA	P.O.	SEQ.	SUB.	ITEM
4261	01	50022	16	A	PT-1222

ITEM PT-1222

MANUFACTURING LOCATION — ORIGINAL DATE

OUTLINE

WORTHINGTON TURBINE INTERNATIONAL, INC.
A DIVISION OF TURBODYNE CORPORATION
WELLSVILLE, NEW YORK 14895 U.S.A.

DRAWN: A. GARROD	DATE: 1-24-75
TRACED:	SCALE: 1.50 = 12.00
CHECKED:	FRAME: 202 WHB
APPROVED:	FIRST USE

LD-143912

PIPING CALCULATIONS

1. THE TOTAL RESULTANT FORCE AND TOTAL RESULTANT MOMENT IMPOSED ON THE TURBINE AT ANY CONNECTION MUST NOT EXCEED THE FOLLOWING

$$F = \frac{A - M}{3}$$

FLANGE	A
INLET	2070
EXHAUST	4000

F = RESULTANT FORCE, INCLUDING PRESSURE FORCES WHERE UNRESTRAINED EXPANSION JOINTS ARE USED AT THE CONNECTION, POUNDS.

M = RESULTANT MOMENT, POUND FEET

2. THE COMBINED RESULTANTS OF THE FORCES AND MOMENTS OF THE INLET AND EXHAUST CONNECTIONS, RESOLVED AT THE CENTERLINES OF THE EXHAUST CONNECTION MUST NOT EXCEED THE FOLLOWING TWO CONDITIONS.

a. THE RESULTANTS MUST NOT EXCEED: $F_c = (2220 - M_c)$

F_c = COMBINED RESULTANT OF INLET AND EXHAUST FORCES, POUNDS.

M_c = COMBINED RESULTANT OF INLET AND EXHAUST MOMENTS AND MOMENTS RESULTING FROM FORCES, POUND FEET.

b. THE COMPONENTS OF THESE RESULTANTS SHALL NOT EXCEED:

F_x = 445 POUNDS	M_x = 2220 POUND FEET
F_y = 1110 POUNDS	M_y = 1110 POUND FEET
F_z = 890 POUNDS	M_z = 1110 POUND FEET

x. PARALLEL TO TURBINE SHAFT
y. VERTICAL
z. HORIZONTAL AND AT RIGHT ANGLES TO TURBINE SHAFT

4 in. INLET
8 in. EXHAUST

WORTHINGTON TURBINE INTERNATIONAL
DRAWN: D.L.
CHECKED: EJR
APPROVED: MS

IMPORTANT
THIS DRAWING HAS BEEN RELEASED FOR PRODUCTION ANY CHANGES MAY AFFECT PRICE AND DELIVERY.

MICROFILMED

THIS PRINT IS CERTIFIED CORRECT FOR
CELANESE CHEMICAL CO. PT-1222
CUSTOMER'S ORDER NO. 50022
BRANCH OFFICE NO.
WORKS ORDER NO. U-19185
APPROVED BY: DATE: 2/21/75

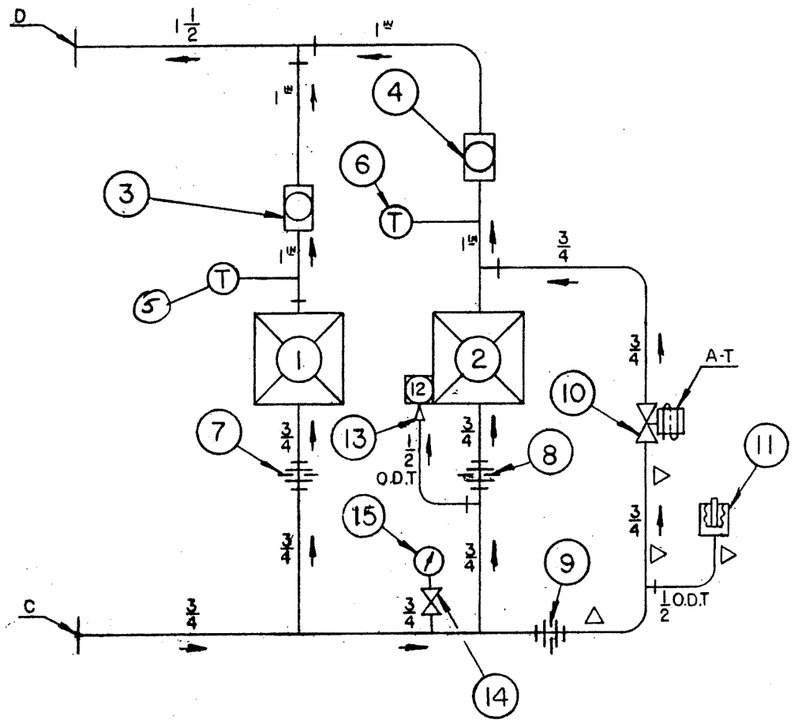
THE CONSTRUCTION SHOWN IS STANDARD FOR THIS MACHINE. ANY DEVIATION FROM STANDARD MAY INVOLVE ADDITIONAL COST. A CORRESPONDING INCREASE IN SELLING PRICE AND DELAY IN SHIPMENT. IF CHANGES ARE NECESSARY INDICATE THEM CAREFULLY AND IN DETAIL ON THIS PRINT AND RETURN TO TURBODYNE CORP. YOU WILL BE ADVISED PROMPTLY AS TO THE ADDITIONAL PRICE. MEANWHILE THOSE DETAILS INVOLVED WILL BE HELD UP UNTIL YOUR AUTHORIZATION TO PROCEED IS RECEIVED.
STEAM TURBINE DIVISION

LC-144997

(12) WORM & WHEEL SPRAY.
(13) 1/4 IN ORIFICE NIPPLE.
(14) 1/2 IN GAUGE VALVE
(15) BEARING OIL PRESSURE GAUGE 2-1/2 DIAL RANGE 0 TO 30 1/4 IN BOTTOM CONNECTED LINE MOUNTED.

OIL REQUIREMENTS

BEAR. OIL ——— 3 GPM AT 15 P.S.I.
DRAIN FROM COUND "" ——— 3 GPM



——— LINES PIPED IN SHOP BY TUBODYNE

△ △ △ △ △ RECOMMENDED LINES TO BE STEAM TRACED - CAUTION: OVER HEATING MAY CAUSE CARBONIZATION OF OIL.

DESCRIPTION

(1) EXHAUST END BEARING.
(2) STEAM END BEARING.
(3) 1" SIGHT FLOW INDICATOR, WITH FLAPPER REMOVED FISHER & PORTER (EXH. END BEARING DRAIN).
(4) 1" SIGHT FLOW INDICATOR, WITH FLAPPER REMOVED FISHER & PORTER (STM. END BEARING DRAIN).
(5) THERMOMETER - 5" DIAL ASHCROFT - EVERY ANGLE 3/4 IN PIPE THD. SEPARABLE SOCKET (EXH. END BEARING DRAIN).
(6) THERMOMETER - 5" DIAL ASHCROFT - EVERY ANGLE 3/4 IN PIPE THD. SEPARABLE SOCKET (STM. END BEARING DRAIN).
(7) ORIFICE PLATE 3/32 IN DIA. HOLE.
(8) ORIFICE PLATE 3/16 IN DIA. HOLE.
(9) ORIFICE PLATE 1/8 IN DIA. HOLE.
(10) 3/4 IN SOLENOID DUMP VALVE - TO TRIP WHEN DE-ENERGIZED.
(11) LOW OIL PRESSURE TRIP SET AT 3 P.S.I. RESET MANUALLY.

NOTES:
1. IDENTIFY ALL CUSTOMERS CONNECTIONS.
2. SHOP TO PROVIDE PIPING SUPPORTS WHERE NECESSARY.
3. SEE OUTLINE DWG FOR SIZE AND LOCATIONS OF CONN'S. D, C, A-T.
4. ALL PIPING MUST BE KEPT WITHIN OUTLINE LIMITATIONS IF POSSIBLE.
5. ALL BUTT WELDED JOINTS TO HAVE FULL PENETRATION.
6. WELDING TO BE DONE PER WORTHINGTON SPEC. W/O. 32.
7. ON ALL FABRICATED PIPING DISSEMBLED FOR SHIPPING TAG EACH END OF BROKEN JOINT WITH CORRESPONDING NUMBER FOR REASSEMBLY ON SITE
8. STN. STEEL PIPE TO BE MECHANICALLY CLEANED AT WELDS AS REQUIRED & SUITABLY WASHED WITH CLEANING FLUID TO REMOVE DIRT.
9. FLANGES IN STN. STEEL LINES ARE SLIP-ON TYPE STN STEEL, AND ARE WELDED FRONT & BACK WITH STN. STL. WELDING ROD.
10. BOLT HOLES IN FLANGES TO STRADDLE CENTERLINES UNLESS OTHER POSITIONING IS SPECIFIED OR SHOWN ON DRAWING.

ITEM - PT-1222

DIAGRAMMATIC SKETCH OF OIL PIPING		LC-144997
WORTHINGTON CORPORATION TURBINE DIVISION WELLSVILLE, N. Y. U. S. A.		
DRAWN: H.C. DUNN	DATE: 4-2-75	
TRACED:	SCALE: N.T.S.	
CHECKED: M.A. 4-28-75	FRAME:	
APPROVED: [illegible] 4-24-75	REST. S.O.: U-19185	

FINAL ISSUE
APPROVED BY
[illegible] 5-9-75
DAY POWERGAS INC.

MICROFILM

PROJ.	AREA	P.O.	SEQ.	SUB.	ITEM
4207	50022		20	A	PT-1222

IMPORTANT
THIS DRAWING HAS BEEN RELEASED FOR PRODUCTION ANY CHANGES MAY AFFECT PRICE AND DELIVERY.

THIS PRINT IS CERTIFIED CORRECT FOR
Celanese Chemical Co.
CUSTOMER'S ORDER NO. 040-041-58022
BRANCH OFFICE NO. 30-40025
WORKS ORDER NO. U-19185
APPROVED BY: J.R. Burger DATE: 4/24/75

THE CONSTRUCTION SHOWN IS STANDARD FOR THIS MACHINE ANY DEVIATION FROM STANDARD MAY INVOLVE ADDITIONAL COST. A CORRESPONDING INCREASE IN SELLING PRICE AND DELAY IN SHIPMENT IF CHANGES ARE NECESSARY INDICATE THEM CAREFULLY AND IN DETAIL ON THIS PRINT AND RETURN TO TURBODYNE CORP. YOU WILL BE ADVISED PROMPTLY AS TO THE ADDITIONAL PRICE. MEANWHILE THOSE DETAILS INVOLVED WILL BE HELD UP UNTIL YOUR AUTHORIZATION TO PROCEED IS RECEIVED.

STEAM TURBINE DIVISION

*6

RECOMMENDED SPARE PARTS FOR TURBINE 19185 SER. NO. 32600

PART NO.	SECTION DRAWING	NAME OF PART	QTY. **	DRAWING NO.	MATERIAL	UNIT PRICE F.O.B. WORKS
	LE-135666-A	MAIN TURBINE BEARINGS				
38		STEAM END BEARING	1	IC-102699-1-2	B&B	$204.00
60		EXHAUST END BEARING	1	IC-81654-1-2	B&B	86.54
348		MAIN BALL THRUST BEARING	1	ND 3311XR	STL	14.84
		TURBINE SHAFT PACKING				
46		Carbon Rings	2	W-35173-1	L51X	16.62
46		Carbon Rings	8	W-35173-2	L51X	16.62
403		Carbon Ring Springs	10	V-12729	INC	4.35
		GOVERNOR WEARING PARTS				
203-7		GOVERNOR VALVE & BUSHING ASSM.	1	25353	---	940.00
201		EMERGENCY VALVE SPINDLE	1	V-9654	STSTL	40.18
752		VALVE LINK	1	LA-126882-1	STSTL	83.03
108		BALL BEARING UPPER DRIVE SHAFT	1	ND#3207	STSTL	2.96
112		BALL BEARING LOWER DRIVE SHAFT	1	ND#3207	STSTL	2.96
100		WORM WHEEL	1	LB-102697-3	STSTL	89.06
2306		GOVERNOR DRIVE SHAFT	1	IC-102695-1	ALLOY STL	106.74
2036		WOODWARD GOVERNOR COUPLING SLEEVE	1	LA-100976-1	STL	103.00
376		Sylphon Bellows	1	W-20024	---	121.00
24		EMERGENCY GOVERNOR CUP	1	LB-102369-1	HRS	
		EMERGENCY GOVERNOR PARTS	1 Set	465561-3		476.00

FINAL ISSUE
APPROVED BY
APPROVAL NOT REQUIRED
ELLIOTT POWERGAS INC.

~~Prices shown~~ are those in effect at this date and are subject to change without notice. Invoice prices will be those in effect at time of shipment."

PROJ. AREA P.O. SEQ. SUB. ITEM
4107 5022 24 A 47-122

Wellsville Q-73223

~~Date Issued:~~ 4/30/75

Estimated Delivery 70-80 Working Days

** QUANTITY OF PARTS PER TURBINE. QUANTITY OF SPARES TO BE STOCKED IS CUSTOMERS OPTION

PROJ,	AREA	P.O.	SEQ.	SUB.	ITEM
4207	50022	30	B		PT-1222 1226 1227

CELANESE CHEMICAL COMPANY

BISHOP, TEXAS

Outline & assembly dwg. -
Also lube oil diagramatic
have not been approved

FINAL ISSUE
APPROVED ■ As Noted
Koretchko 10-6-75
DAVY POWERGAS INC.

INSTRUCTIONS FOR

SINGLE STAGE

NON-CONDENSING STEAM TURBINES

TURBINE SERIAL NUMBERS

32597 - 32598 - 32600

WELLSVILLE WORKS ORDER NUMBERS
U - 19183 - U-19185

TURBODYNE
CORPORATION
STEAM TURBINE DIVISION
WELLSVILLE, NEW YORK 14895

Aug. 1975

TURBINE DATA SHEET

U-19183 - U-19185

Serial Numbers - 32597 - 32598 (U-19183)
32600 (U-19185)

Turbine Frame - 282 WHB (U-19183)
202 WHB (U-19185)

Number of Turbine Stages - 1 Curtis

Driven Machine - Bingham Boiler Feed Water Pump (U-19183)
Forced Draft Fan (U-19185)

Turbine Rating - 619 H.P. at 3600 R.P.M. (U-19183)
440 H.P. at 4760 R.P.M. (U-19185)

Turbine Rotation Viewed From Governor End of Turbine - Counterclockwise

Inlet Steam Conditions - 240 psig. at 403° F.T.T.

Exhaust Condition - 50 psig.

Variable Conditions - 250 psig. - 406° F.T.T. - 55 psig. (Maximum)
240 psig. - 403° F.T.T. - 40 psig. (Minimum)

Casing Material - Cast Steel

Shaft Packing - 5 Carbon Rings in Each Packing Case

Bearing Pressure - 8 psig. (U-19183)
15 psig. (U-19185)

Low Oil Pressure Trip To Trip Out Turbine At - 3 psig.; Reset 4.5 psig. (U-19183)
3 psig.; Reset Manually (U-19185)

Low Oil Pressure Alarm Switch Set to Alarm At 4.8 psig. Falling Oil Pressure

Quantity of Fresh Cooling Water Required For Oil Cooler - 12 G.P.M. at 90° F.(U-19183)

Auxiliary Oil Pump - Motor Driven - Capacity 9.4 G.P.M. at 28 psig. (U-19183)
Pump To Cut In At 6 psig. - Cut Out at 7 psig.

High Oil Temperature Alarm Switch Set At - 130° F. (U-19183)

Solenoid Dump Valve To Trip When - Energized (U-19183)
De-Energized (U-19185)

Emergency Overspeed Trip Setting -- 4158 R.P.M. (U-19183)
5500 R.P.M. (U-19185)

TURBINE DATA SHEET

U-19183 - 19185

Sentinel Warning Valve Set To Open At - 90 psig.

Journal Bearing Information:

Shaft Bearing Journal Size -	Bearing Bore -
Steam End - $2.620^{+.000}_{-.001}$	$2.626^{+.001}_{-.000}$
Exhaust End - $2.620^{+.000}_{-.001}$	$2.626^{+.001}_{-.000}$

Turbine Main Journal Running Clearance: Steam End - .006" to .008"
Exhaust End - .006" to .008"

Governor Valve Size - 3-5/8" (U-19183)
4" (U-19185)

Speed Governor - Woodward Direct Acting PG-PL

Governor Air Signal - Turbine Speed Relationship

U-19183	U-19185
3 psig. - 2700 R.P.M.	2850 R.P.M.
15 psig. - 3780 R.P.M.	5000 R.P.M.

Governor Speed Setting - 3600 R.P.M. (U-19183)
4760 R.P.M. (U-19185)

Exhaust Relief Valve To Start Opening at 100 (U-19183) / 130 (U-19185) psig., to be fully open at U-19183) 110 / (U-19185) 145 psig. to pass 32,430 / 23,582 #/hr. (U-19185)

Number of Hand Valves - Two (2) for Part Load

Valves Open (U-19183)	H.P. Load at Rated Condition (U-19183)	U-19185)
Governor (Hand Valves Closed)	356	246
# 1	490	339
# 1 - # 2	619	440

TURBINE WEIGHTS - See Outline Drawing, Figure A-1

WARNING! EYEBOLT IN TURBINE CASE COVER TO BE USED FOR LIFTING TURBINE CASE COVER ONLY

QUANTITY GR. 2	QUANTITY GR. 1	DESCRIPTION OF PART	DRAWING NO. & ITEM NO.	PATTERN NO.	MATERIAL	MATERIAL SPEC. NO.	PROCESS SPEC. NO.	ITEM NO.

PIPING CALCULATIONS

1. THE TOTAL RESULTANT FORCE AND TOTAL RESULTANT MOMENT IMPOSED ON THE TURBINE AT ANY CONNECTION MUST NOT EXCEED THE FOLLOWING:

$$F = \frac{A-M}{3}$$

FLANGE	A
INLET	2000
EXHAUST	4000

F = RESULTANT FORCE, INCLUDING PRESSURE FORCES WHERE UNRESTRAINED EXPANSION JOINTS ARE USED AT THE CONNECTION, POUNDS.

M = RESULTANT MOMENT, POUND FEET

2. THE COMBINED RESULTANTS OF THE FORCES AND MOMENTS OF THE INLET ANDEXHAUST CONNECTIONS, RESOLVED AT THE CENTERLINES OF THE EXHAUST CONNECTION MUST NOT EXCEED THE FOLLOWING TWO CONDITIONS.

   a. THE RESULTANTS MUST NOT EXCEED: $F_c = \frac{2220 - M_c}{2}$

      F_c = COMBINED RESULTANT OF INLET AND EXHAUST FORCES, POUNDS.

      M_c = COMBINED RESULTANT OF INLET AND EXHAUST MOMENTS AND MOMENTS RESULTING FROM FORCES, POUND FEET.

   b. THE COMPONENTS OF THESE RESULTANTS SHALL NOT EXCEED:

F_x =	445 POUNDS	M_x =	2220 POUND FEET
F_y =	1110 POUNDS	M_y =	1110 POUND FEET
F_z =	890 POUNDS	M_z =	1110 POUND FEET

x, PARALLEL TO TURBINE SHAFT

y, VERTICAL

z, HORIZONTAL AND AT RIGHT ANGLES TO TURBINE SHAFT

TOLERANCE FOR DIMENSIONS TO HUNDREDTHS OF AN INCH
1 - FINISHED SURFACE ± .02
2 - UNFINISHED SURFACE ± .05

REF.

REVISIONS

1 ROUGH 250 | 25 SMOOTH 63 | 2 FINE 125 | 3 GRIND 32 | 4 POLISH 16

4 in. INLET
8 in. EXHAUST

WORTHINGTON TURBINE INTERNATIONAL, INC.
A DIVISION OF TURBODYNE CORPORATION
WELLSVILLE, NEW YORK 14895 U.S.A.

DRAWN: D.L.	DATE:
TRACED:	SCALE:
CHECKED: F.J.R.	FRAME:
APPROVED: M.S. 6-9-70	FIRST S.O.:

LA-12537A

QUANTITY GR. 2	QUANTITY GR. 1	DESCRIPTION OF PART	DRAWING NO. & ITEM NO.	PATTERN NO.	MATERIAL	MATERIAL SPEC. NO.	PROCESS SPEC. NO.	ITEM NO.

PIPING CALCULATIONS

1. THE TOTAL RESULTANT FORCE AND TOTAL RESULTANT MOMENT IMPOSED ON THE TURBINE AT ANY CONNECTION MUST NOT EXCEED THE FOLLOWING:

$$F = \frac{A-M}{3}$$

FLANGE	A
INLET	3000
EXHAUST	4660

F = RESULTANT FORCE, INCLUDING PRESSURE FORCES WHERE UNRESTRAINED EXPANSION JOINTS ARE USED AT THE CONNECTION, POUNDS.

M - RESULTANT MOMENT, POUND FEET

2. THE COMBINED RESULTANTS OF THE FORCES AND MOMENTS OF THE INLET AND EXHAUST CONNECTIONS, RESOLVED AT THE CENTERLINES OF THE EXHAUST CONNECTION MUST NOT EXCEED THE FOLLOWING TWO CONDITIONS

   a. THE RESULTANTS MUST NOT EXCEED: $F_C = \frac{2600 - M_C}{2}$

      F_c = COMBINED RESULTANT OF INLET AND EXHAUST FORCES, POUNDS.

      M_c = COMBINED RESULTANT OF INLET AND EXHAUST MOMENTS AND MOMENTS RESULTING FROM FORCES, POUND FEET.

   b. THE COMPONENTS OF THESE RESULTANTS SHALL NOT EXCEED:

F_x =	520 POUNDS	M_x =	2600 POUND FEET
F_y =	1300 POUNDS	M_y =	1300 POUND FEET
F_z =	1040 POUNDS	M_z =	1300 POUND FEET

x PARALLEL TO TURBINE SHAFT

y, VERTICAL

z, HORIZONTAL AND AT RIGHT ANGLES TO TURBINE SHAFT

TOLERANCE FOR DIMENSIONS TO HUNDREDTHS OF AN INCH
1 - FINISHED SURFACE ±.02
2 - UNFINISHED SURFACE ±.05

REF.

REVISIONS

1 ROUGH 250 | 2S SMOOTH 63 | 2 FINE 125 | 3 GRIND 32 | 4 POLISH 16

6 in. INLET
12 in. EXHAUST

WORTHINGTON TURBINE INTERNATIONAL, INC.
A DIVISION OF TURBODYNE CORPORATION
WELLSVILLE, NEW YORK 14895 U.S.A.

DRAWN: D. L.	DATE:
TRACED:	SCALE:
CHECKED: F.J.R.	FRAME:
APPROVED: M.S. 6-9-70	FIRST S.O.:

LA-12537