SOLAR

DIVISION OF INTERNATIONAL HARVESTER COMPANY
2200 PACIFIC HIGHWAY, SAN DIEGO, CALIFORNIA

FACTORY PERFORMANCE TEST REPORT
CENTAUR GAS TURBINE COMPRESSOR SET
MODEL CSS-3168H
FOR
V/O MACHINOIMPORT, MOSCOW, USSR

241 / 6

REPORT SD 4144 ISSUED December 1973

PACKAGE:

Model CSS-3168H
Serial No.: 3020138

Engine Model: T-3002
Serial No.: 3000241

Compressor Model: C-1688-2510H
Serial No.: 2344

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CUSTOMER REF 50-32/40927

SOLAR REF 2-06710

TRANS NO. 873207

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SECTION 1

INTRODUCTION

Each major component of the Model CSS-3168H Gas Compressor Set is subjected to qualification tests before delivery to the customer. Testing consists of:

- Gas-turbine engine test
- Gas compressor test
- High speed gear unit test
- Package acceptance test

Testing operations are conducted under the direct supervision of Solar's Quality Control and Test activity. This activity functions independently of production departments to ensure compliance with the test procedures specified.

In addition to in-plant testing of the gas-turbine engine and gas compressor, quality control engineers maintain surveillance over the manufacture of purchased parts and subassemblies, and are responsible for functional testing of incoming components. The same standards applied to parts manufactured by Solar are thus assured in parts received from Solar's suppliers.

1.1 APPLICABLE SPECIFICATIONS

The applicable testing specifications and documents for this report are listed below.

ES 1459E	Green Run Testing, Solar T-3002 Gas Turbine Engine (1550°F-Uprated)
ES 1408B	Centrifugal Gas Compressors, Performance Testing
ES 1326	High Speed Gear Unit for Centaur Turbine Packages
ES 1419C	Acceptance Test, Solar Model CS-3000, Centaur Turbine Gas Compressor Set

PTC 10	ASME Performance Test Code for Compressors and Exhausters (Interim Supplement 19.5 on Instruments and Apparatus, Sixth Edition, 1971)

1.2 GAS-TURBINE ENGINE TEST

Before assembly into the packaged set, every Centaur gas-turbine engine is subjected to a run-in and calibration test (green run test). For this test, the engine power is absorbed by a high-speed dynamometer, enabling aspects of engine performance to be measured. A 6-hour run at incremental loads up to full speed and power ensures functional and structural integrity. Details of engine green run testing are described in Specification ES 1459E.

1.3 GAS COMPRESSOR TEST

The gas compressor is subjected to a rig test similar to the procedure used for the gas turbine run-in test. This test is followed by installation in the package prior to shipment. If the compressor does not conform to specified performance, it goes through teardown, inspection, rebuild, and retest prior to package installation.

Prior to build, the compressor casings have been assembled and subjected to a hydrostatic test to 150 percent of the maximum working pressure rating.

During the rig test, the compressor is driven at significant operational speeds by a slave driver. Extensive instrumentation verifies that mechanical and aerodynamic performance conforms as closely as possible to the predicted performance originally proposed to the customer.

The compressor for this particular package went through special tests on the closed-loop rig. Using nitrogen at various suction pressures instead of atmospheric air, closed-loop rig testing facilitates evaluation of the high pressure effects on the compressor.

1.4 HIGH SPEED GEAR UNIT TEST

Basic factory performance testing of the gearbox is conducted by the manufacturer, Philadelphia Gear Corporation, in accordance with Specification ES 1326. The gearbox is subjected to additional tests up to full load and speed during package acceptance testing.

1.5 PACKAGE ACCEPTANCE TEST

After satisfactory completion of the green run tests for the engine and gas compressor, they are installed in the gas compressor package in preparation for the package acceptance test. This test specifies procedures and requirements to be met for the hydraulic, pneumatic, and electrical systems supplied with the gas compressor set. During the acceptance test, the engine safety shutdown system is tested under actual operating conditions by introducing, or simulating, the various safety shutdowns. After completion of the acceptance test, the package undergoes a preservation run and is prepared for shipment to the customer. Details of package testing are outlined in Specification ES 1419C.

SECTION 2

ENGINE GREEN RUN TEST SUMMARY

Before assembly into a gas compressor package, each Centaur gas-turbine engine is subjected to a dynamometer testing in one of Solar's production test cells. The test cell contains the necessary equipment and instrumentation to determine the engine's mechanical and aerodynamic performance at different speeds.

2.1 METHOD AND PROCEDURE

2.1.1 Instrumentation

Instrumentation used in the test cell is calibrated at regular intervals. Airflow measuring equipment conforms to the requirements of ASME Power Test Code, PTC 10.

2.1.2 Engine Operating Conditions

Applicable sections of Test Specification ES 1459E cover the full operating range of the engine, and the significant parameters called out by the specification are recorded; acceptable ranges for these measurements are stated in the specification so that any performance irregularities can be detected.

2.1.3 Analytical Procedure

Recorded data from the engine test runs are analyzed by computer.

The computer analysis is generally conducted in the following manner:

- Engine airflow is computed from the ambient pressure, the pressure differential measured across the air intake venturi, and the venturi diameter and temperature, in accordance with the ASME flow measurement code.
- The fuel flow is computed from relationships involving fuel inlet pressure, air/fuel density ratio, and the flow meter reading.

- The power output (shp) is calculated from the dynamometer-measured load and speed.
- The compressor pressure ratio is computed from the measured compressor discharge total pressure and the inlet static pressure.
- Compressor temperature rise is calculated from measured values and is used with the compressor pressure ratio and the calculated power output to compute the thermodynamic characteristics of the engine.
- The specific fuel consumption (sfc) is computed from calculated fuel flow, fuel heating value, and measured power output.
- Engine test performance is compared with specified performance.

2.2 RESULTS AND DISCUSSION

During the green run test, the engine is operated to design conditions by increasing the power turbine load until a specified match speed is reached. At this speed, the engine must produce the minimum specified power commensurate with a turbine inlet gas temperature at or below the level the engine is allowed to operate for continuous duty service.

Table 1 shows engine green run performance test data. Performance criteria for the T-3002 Centaur engine are also shown in Table 1. Performance data are compared with the required standard, having been corrected to conditions of sea level, zero duct losses, and 80°F engine inlet temperature.

Figure 1 is a copy of the engine green run performance computer analysis. Figure 2 locates the demonstrated test performance within the minimum performance grid.

Table 1. Engine Green Run Performance Test Data

CENTAUR T-3002
PERFORMANCE ACCEPTANCE CRITERIA
and
TEST RESULTS

ENGINE S/N 3000241

TEST DATE 11-27-73

DATA LINE NO. 9

REFERENCE: ES 1459 E		пределы LIMITS	рез-т испытан TEST RESULT	Production Test STAMP OFF
FINAL VANE SETTING посадка лопаток турбины		0^{o} - $+7^{o}$	$+2.25^{o}$	QCE-
SHP CORRECTED мощн.		3380 - 3600	3414	QCE-
SPEED CORRECTED обороты	$N_{gp}/\sqrt{\theta 80}$ %	99.9 - 100.1	100.0	QCE-
CORRECTED t-ра на входе TURBINE INLET °F $T_{3W/\theta 80}$ TEMPERATURE	жидкое топливо Liq Fuel ☐	1530 - 1565		QCE-
	газ топливо Gas Fuel ☑	1530 - 1550	1550	
TEMPERATURE RATIO отношение t	$T_5(^{o}R)/T_{3W}(^{o}R)$	0.761 - 0.776	0.779	0/MAX .003
S F C потребление топлива	BTU/ hp-hr	9100 - 9900	9705	QCE-
FUEL AIR RATIO FACTOR отношение воздух топливо		48 - 54	51.79	QCE-
COMP. PRESSURE RATIO отношение давлений	P2/P1	8.3 - 8.9	8.52	QCE-
COMP. MASS FLOW, CORR.	$W_a\sqrt{\theta 80}/\delta$	34.0 - 37.0	35.06	QCE-
LUBE OIL PRESSURE, (AT 62- 104% Ngp) 5 INLET PORTS давл. масла	PSIG смазки	45 - 70	WITHIN LIMITS	QCE-
LUBE OIL TEMPERATURE t-ра масла (OIL COOLER OUT) смазки	°F	180 Max	152	QCE-
расход масла OIL FLOWS GPM при AT 140 - 160 °F 45 - 70 PSIG	#1 BEARING подшипн. №	3.5 - 5.0	4.15	QCE-
	#2 BEARING	11.0 - 16.0	15.05	QCE-
	#3 BEARING	6.0 - 9.0	7.55	QCE-
	#4 BEARING	7.0 - 10.0	9.77	QCE-
	#5 BEARING	6.5 - 10.5	9.85	QCE-
VIBRATION WITHIN LIMITS OF FIG. 5 Вибрация в пределах рис. 5			YES	QCE-
Давление на входе масл. бака в пределах OIL TANK VENT PRESSURE WITHIN LIMITS OF FIG. 3 рис. 3			O.K.	QCE-
Давление воздуха для охлаждения турбины в TURBINE COOLING AIR PREWSURE WITHIN LIMITS OF FIG. 4 пределах рис. 4			O.K.	QCE-

```
ALL TEMP UNITS F DEGREES
PRESSURE UNITS AS SPECIFIED
1 FOR CENT•SINGLE SF•;2 FOR CENT•SPLIT SF•? 2


T-3002 GREEN RUN PERFORMANCE
1 FOR E5140;2 FOR E5145?? 2
UNIT S/N,DATE,DATA SH LINE NO•? 500241 11-27-1973 LINE 9 +2•25 DEGR TIV
P(BARO)IN•HG?30•03
T(BARO)?63
ENGINE INLET TEMP,T0?55
PT SPEED COUNT?11440
GAS PRODUCER RPM,N(GP)?14305
VENTURI DEPRESSION,IN•H20,DEL P(V)?27•7
VENTURI TEMP,T(V)?55
STATIC PCD(PSIG)?108
INLET PRESSURE LOSS,IN•H20,DEL P(IN)?2•2
EXH•PRESS•LOSS,IN•H20,DEL P(EXH)(3 VALUES,0'S IF REQ'D)?0,0,0
TURBINE EXHAUST TEMP,T7(5 VALUES,0'S IF REQ'D)?753,755,756,756,754
OUTPUT SHAFT HP?3298
PT INLET TEMP,T5(6 VALUES,0'S IF REQ'D)?1021,1103,957,1010,1064,1048
CPS FROM FLOW METER?1615
FM CONT•NO•(155,181,185,186,194)?185
FUEL SUPPLY PRESSURE,PSIG,P(F)?188
FUEL SUPPLY TEMP,T(F)?93
1 FOR NATL GAS;2 FOR PROPANE?1
HHV VALUE(0 IF UNKNOWN)?1052

*OUTPUT*
DENSITY,AIR,LB/CU•FT,RHO(AIR) •080849
DENSITY,GAS,WITH 7,LB/CU•FT•RHO(GAS) •618899
FUEL FLOW,WF(CFM) 42•5862
FUEL FLOW,WF(PPH) 1581•39
FUEL FLOW,DIES,WF(PPH) 1751•4
STD TEMP CORR,THETA(80) ; SQ RT OF •953678                    •976565
CORR PT RPM 93•2686
CORR GP RPM 100•036
COMPR MASS FLOW,WA(PPS) 35•713
COMPR TEMP RISE FACTOR,Y •835415
MAX TEMP FROM WORK,T3W 1456•86
CORR MAX TEMP FROM WORK•T3W/THETA(80) 1549•95
CORR PT INLET TEMP,T5/THETA(80) 1105•38
SHP NO LOSS 3334•84
CORR SHP NO LOSS 3414•02
CORR FUEL FLOW,NO LOSS,WF(PPH) 1802•72
SFC(BTU/HP HR) 9705•27
FUEL AIR RATIO FACTOR 51•7869
COMPR PRESS RATIO,R(C) 8•51628
INLET LOSS CORR FACTOR(DELTA PRIME) •994598
CORR COMPR MASS FLOW,WA CORR(PPS) 35•0567
T5(R)/T3W(R) •779278
OUT OF SPEC(•761-•775)
```

Figure 1. Engine Green Run Performance Computer Analysis

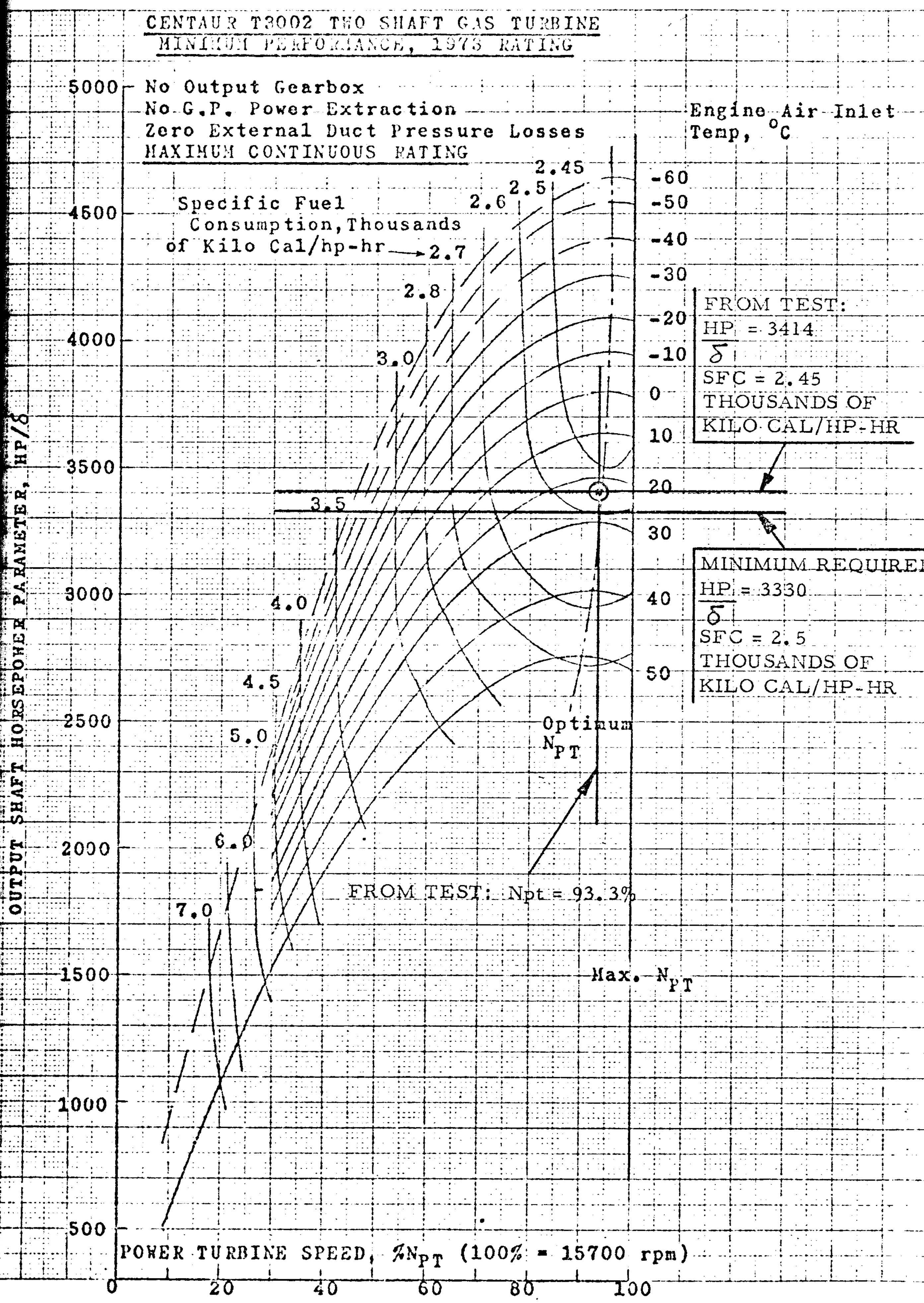


Figure 2. Test Performance vs. Minimum Required Performance

SECTION 3

GAS COMPRESSOR CLOSED-LOOP TEST SUMMARY

he gas compressor for this particular package was subjected to testing in Solar's osed-loop rig, using high pressure nitrogen. The closed-loop rig contains the cessary equipment and instrumentation to determine the compressor's mechanical d aerodynamic performance at different speeds.

perating the gas compressor at predetermined suction pressures and speeds, the rformance is evaluated by mapping pressure ratios versus flows. The speed line hich produces the same Mach number effects as the one passing through the natural s design point is chosen for performance evaluation. Closed-loop rig performance continuously compared with the predicted performance for this specific speed line.

1 METHOD AND PROCEDURE

1.1 Closed-Loop Rig Test Results and Estimated Compressor Performance

stimated compressor performance for gas is shown in figures 3 and 4. This per-rmance can be obtained only with gas properties as stated on the estimated perfor-ance curves.

ompressor performance, when evaluated on the basis of isentropic head versus lumetric flow, is considered to be essentially independent of gas properties. nall differences between performance obtained on air and natural gas may be eglected for small numbers of stages or heavy gas. In the case of multistage or ght gas applications, however, it is necessary to account for differences in stage atching. These differences are included in the performance predictions corres-onding to a specific gas condition.

able 2 contains the basic relationships of the boost compressor performance arameters.

Table 2. Compressor Parameters and Equations

Equations for Compressor Isentropic Head and Volumetric Flow

a. $$Hd = \frac{(T_1)(53.3)\ (Z)(k)}{(SG)\ (k-1)} \left[\left(\frac{P_2}{P_1} \right)^{\left(\frac{k-1}{k} \right)} - 1 \right] \quad \text{ft}$$

b. $$Q_1 = \frac{(MMSCFD)\ (1000)\ (Z)\ (14.7)\ (T_1)}{(1.44)\ (P_1)\ (520)} \quad \text{cfm}$$

Equations for Head and Flow Coefficients

c. $$\Psi = \frac{(2g)\ (Hd)}{U_2^{\,2}}$$

d. $$\Phi_1 = \frac{(144)\ (Q_1)}{(\pi)\ (60)\ (D_2^{\,2})\ (U_2)/4}$$

e. $$U_2 = \frac{(\pi)\ (D_2)\ (N)}{(60)\ (12)} \quad \text{ft/sec}$$

Glossary of Terms

Symbol	Nomenclature	Units
Hd	Isentropic head	feet футы
k	Ratio of specific heats	---
MMSCFD	Standard volumetric flow at P = 14.7 psia, T = 60°F (millions standard cubic feet per day)	$10^6 ft^3$/day день
N	Gas compressor speed	rpm об/мин
P_1	Gas flow total pressure at compressor inlet	psia
P_2	Gas flow total pressure at compressor discharge	psia
Q_1	Volumetric flow at inlet conditions объемный поток	cfm
SG	Gas specific gravity with respect to air	---
T_1	Gas flow total temperature at compressor inlet	°F or °R
Z	Supercompressibility factor	---
Ψ	Head Coefficient	---
Φ_1	Flow Coefficient	---
g	Acceleration due to gravity (standard = 32.174)	ft/sec^2
U_2	Impeller tip velocity	ft/sec
D_2	Impeller tip diameter	in.

For Air: SG = 1, Z = 1, k = 1.395
воздух

For Nitrogen: SG = 0.967, Z = 0.98 - 1, k = 1.402
азот

.1.2 Solar Test Cell Performance

nstrumentation. Instrumentation used in the test cell is calibrated at regular ntervals and conforms to recommendations made in the ASME Power Test Code or Compressors and Exhausters, PTC 10.

ompressor Operating Conditions. The compressor is operated at various data oints during closed - loop rig testing. Pertinent data are taken at these points to etermine compressor performance at the equivalent design speed over the full perating range (i.e., from surge to choke), and to ensure adequate capacity at ntermediate speeds.

ata Recording. Basic data recording requirements are listed in ES 1408B.

ata Analysis. In accordance with Test Specification ES 1408B, a computer nalysis of the compressor test data was performed.

nalysis included:

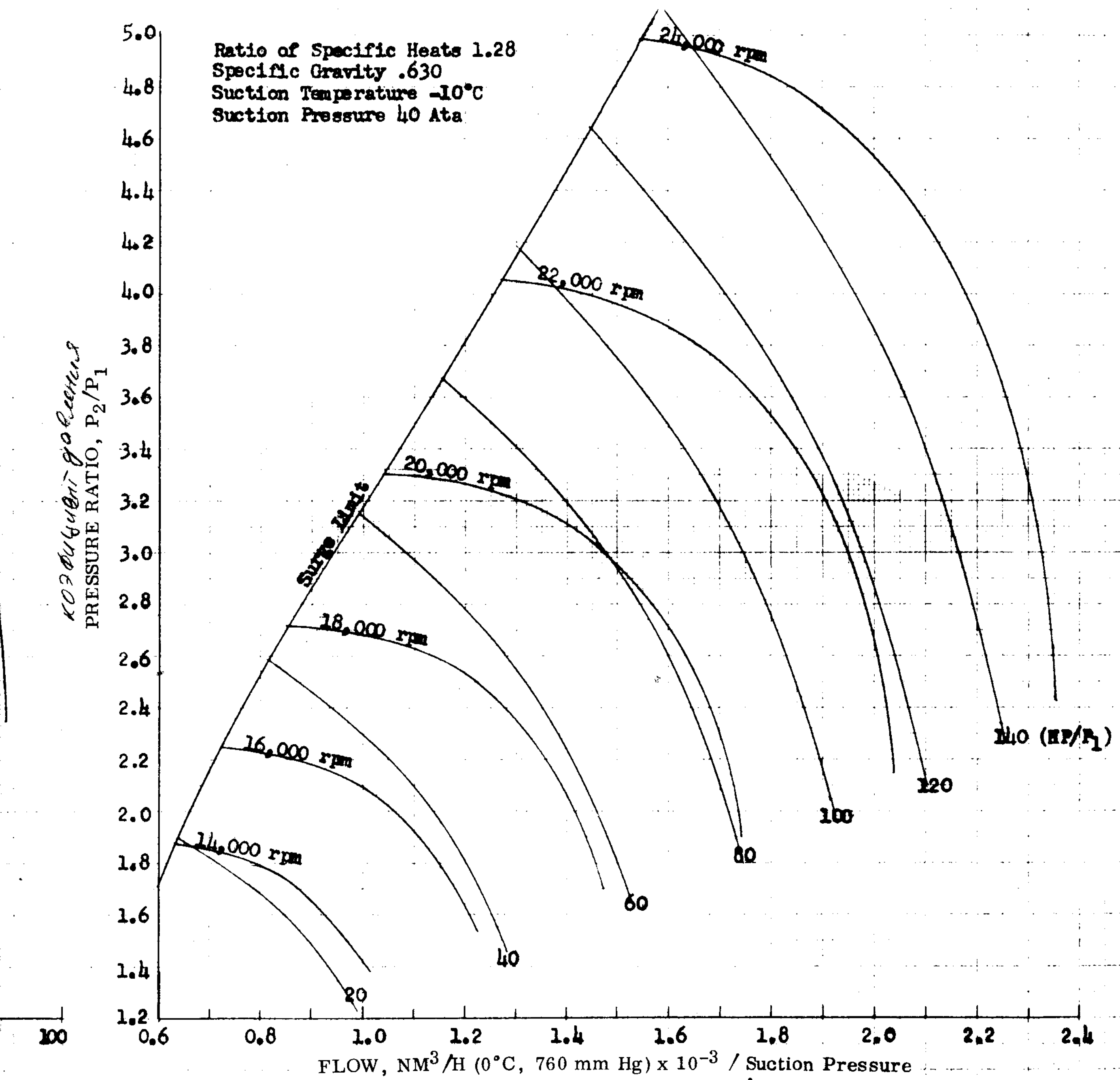
- Isentropic head - computed using the compressor inlet temperature and pressure, and the discharge pressure.
- Airflow - computed using barometric pressure and orifice diameter, inlet temperature, and orifice pressure differential, as described in ASME power test code PTC 10.
- Psi, head coefficient - computed using isentropic head and impeller tip velocity.
- Phi, flow coefficient - computed using volumetric flow, and impeller tip diameter and speed.

.2 RESULTS AND DISCUSSION

he compressor's estimated design performance to meet the customer's design onditions is shown in figures 3 and 4.

n figure 5, the closed-loop rig test performance results are shown as Ψ- and Φ- versus- plots, superimposed on estimated rig test performance curves. The plots are based n the results of the compressor closed-loop performance computer analysis, shown n figure 6.

CR-9668
25 Oct. 1973
I.A.Brewer



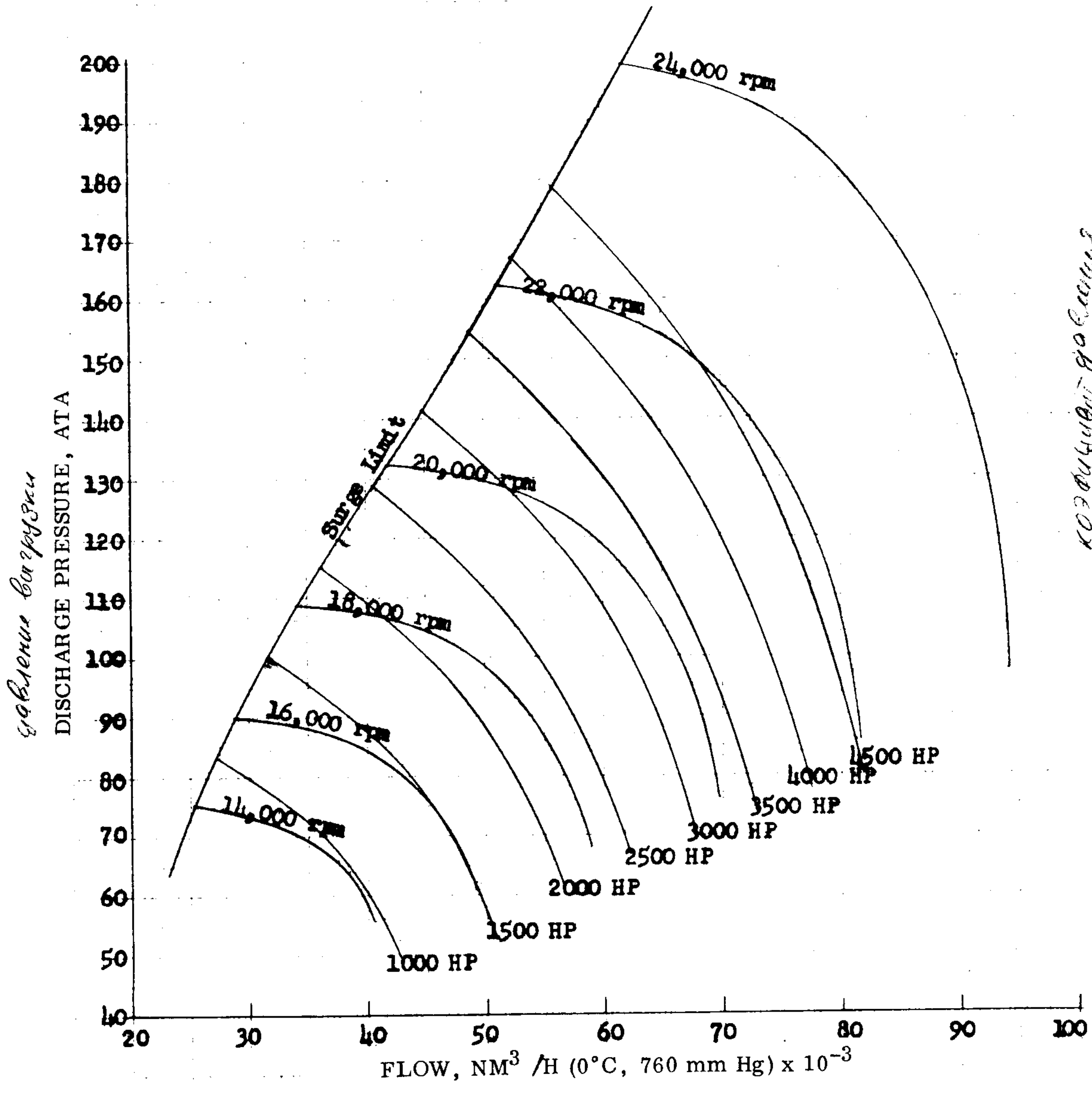
всасывании давления

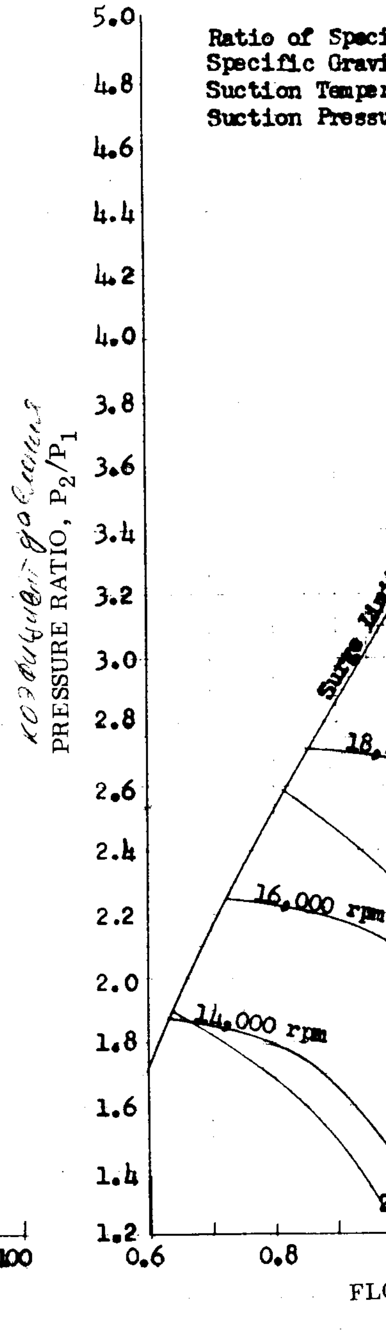
Figure 3. Estimated Compressor Performance for Gas

предполагаемое исполнение компрессора

ESTIMATED PERFORMANCE
C1688-2510H COMPRESSOR

V/O MACHINOIMPORT - S.O. 2-06710





ESTIMATED PERFORMANCE
C1688-2510H COMPRESSOR

CS-20851

25 Oct. 1973

V/O MACHINOIMPORT - S.O. 2-06710

I.A. Brewer

Ratio of Specific Heats 1.28
Specific Gravity .630
Suction Temperature -10°C
Suction Pressure 40 Ata.

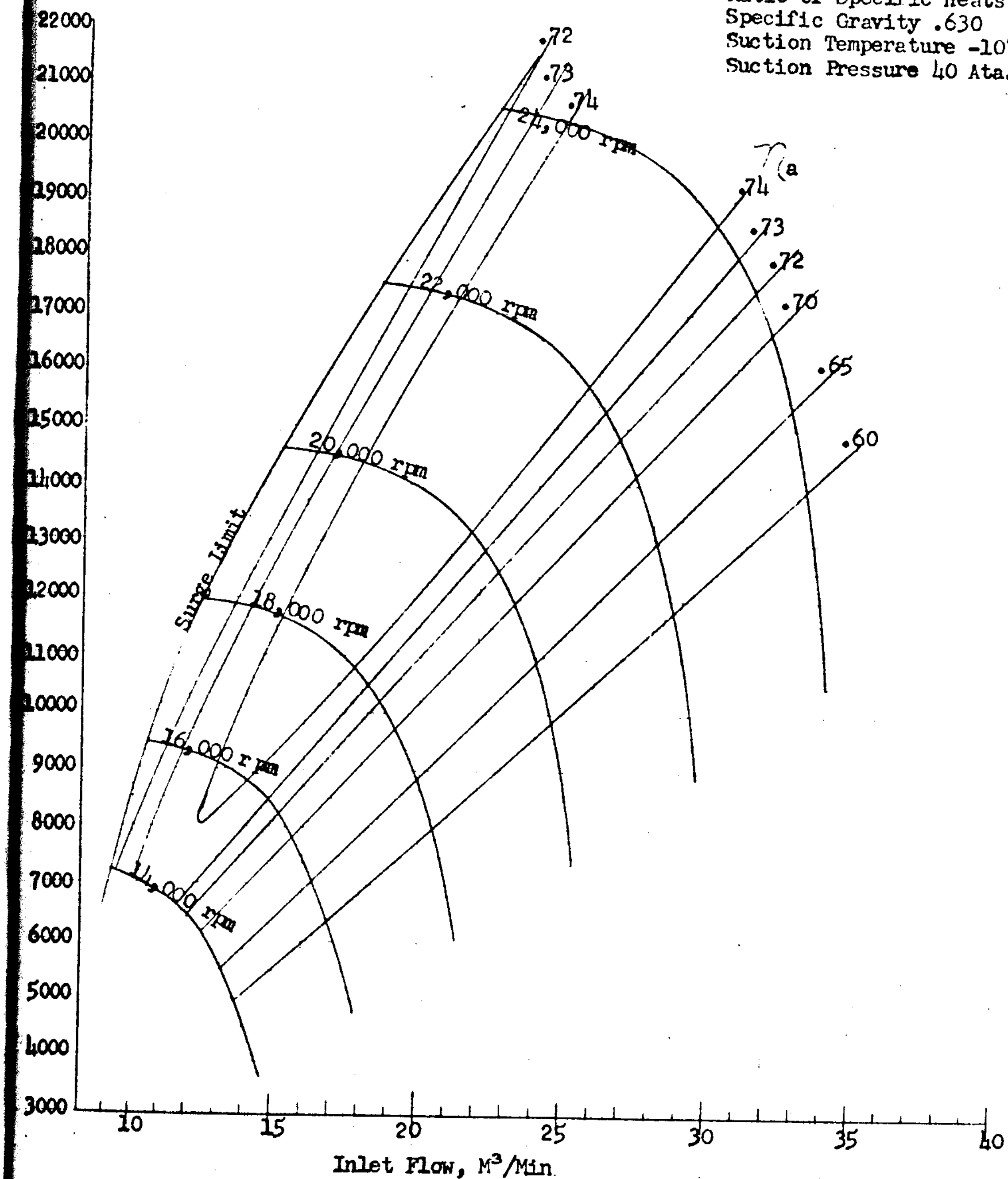


Figure 4. Estimated Compressor Performance for Gas

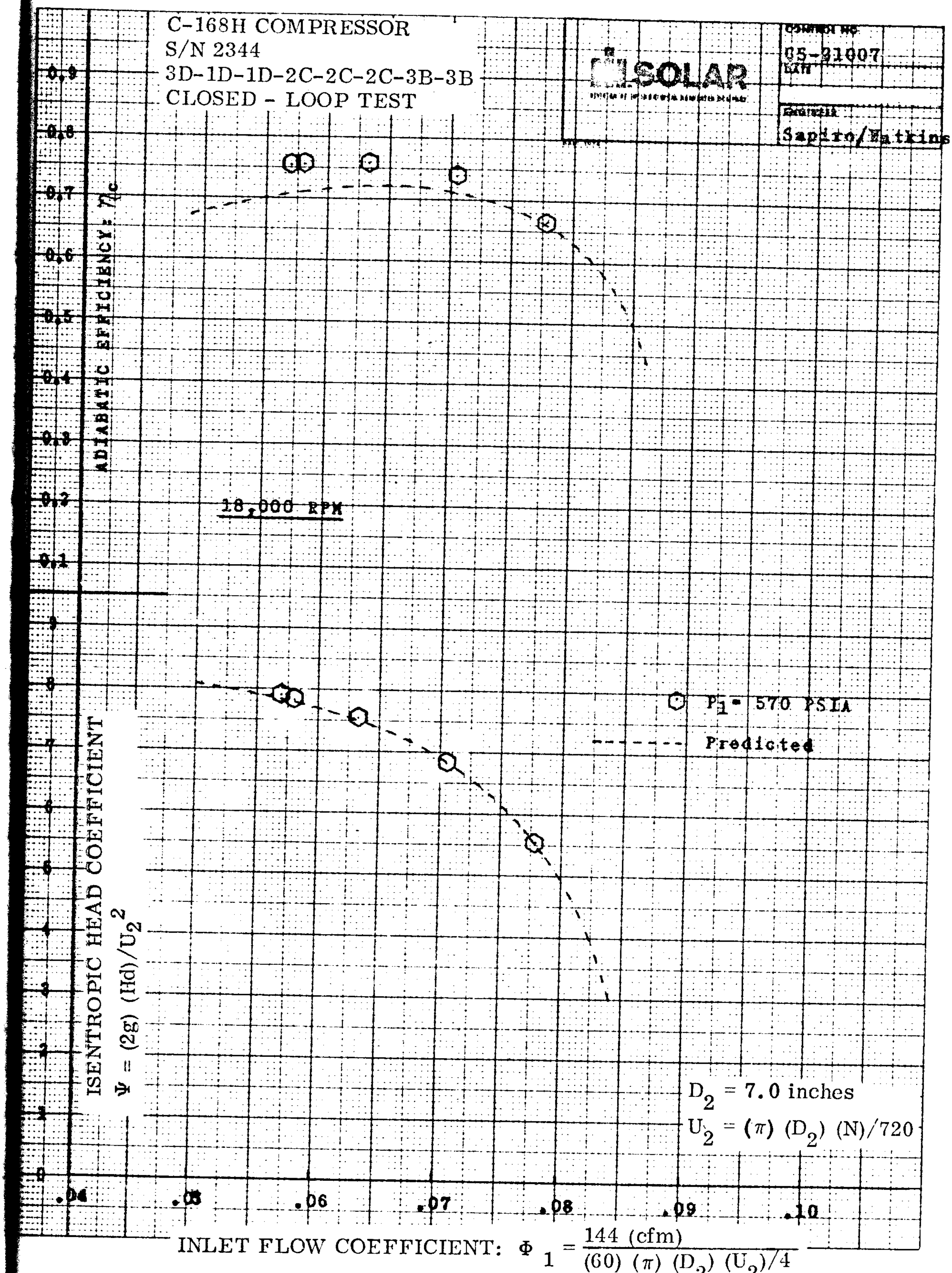


Figure 5. Test Performance vs. Predicted Performance

```
TEST PERFORMANCE OF CENTRIFUGAL COMPRESSORS
ALL TEMPS IN DEG F; ALL PRESSURES IN PSIG UOS
USE O'S TO PROVIDE NO. OF VALUES REQUESTED
CASE IDENT.? 1
RPM RATIO(ACT/CT)? 1.95875
IMP.TIP DIA(IN.)? 7
METER TYPE (1 FOR VENT.,2 FOR ORIFICE)? 2
ORIFICE DIA; PIPE DIA? 3.5,21.522
GB EFFICIENCY? 0.98
SUPERCOMP.? 0.985


DP NO.  43
SHAFT SPD(COUNT)  9199
TEMP.,FLOW MTR              79.3
PRESS., ORIFICE  588
TEMP.,INLET              81.7
TEMP.,DISCH              289.2
DELTA P(V) IN. H2O              591.5
PRESS., INLET              554.5
PRESS.,DISCHARGE              1241
BARO.PRESS,IN.HG;AMBIENT TEMP.  30.26,70
DP NO.  P4/P1        EFF.       DEL T(C)/T1   RPM(CORR)
 43     2.20585      .664363     .383266      17641.9

PSI          CFM          PHI            HEAD       AIR FLOW
 5.55        586.669      7.78107E-02    26102.5    31.8721

MMSCFD       HP           RPM
 37.3411     2346.73      18018.5


DP NO.  44
SHAFT SPD(COUNT)  9194
TEMP.,FLOW MTR              82.6
PRESS., ORIFICE? 584
TEMP.,INLET              85.3
TEMP.,DISCH              313.8
DELTA P(V) IN. H2O              486
PRESS., INLET              556.5
PRESS.,DISCHARGE              1449.3
BARO.PRESS,IN.HG;AMBIENT TEMP.  30.26,70
DP NO.  P4/P1        EFF.       DEL T(C)/T1   RPM(CORR)
 44     2.56274      .738794     .419266      17573.9

PSI          CFM          PHI            HEAD       AIR FLOW
 6.8038      621.567      7.04719E-02    31964.6    28.7605

MMSCFD       HP           RPM
 33.6956     2331.94      18008.7
```

ure 6. Compressor Closed-Loop Performance Computer Analysis (Sheet 1)

```
DP NO.  45
SHAFT SPD(COUNT)  90-198
TEMP.,FLOW MTR              81.2
PRESS., ORIFICE  573
TEMP.,INLET              85.4
TEMP.,DISCH              331.5
DELTA P(V) IN. H2O                394
PRESS., INLET                556.5
PRESS.,DISCHARGE                1581.7
BARO.PRESS,IN.HG;AMBIENT TEMP.  30.26,70
DP NO.  P4/P1        EFF.       DEL T(C)/T1   RPM(CORR)
 45     2.79449      .758999     .451477      17580.

PSI          CFM           PHI           HEAD       AIR FLOW
 7.52172      558.53        6.32973E-02    35358.1      25.8389

MMSCFD        HP           RPM
 30.2727      2255.43       18016.6
DP NO.  46
SHAFT SPD(COUNT)  9207
TEMP.,FLOW MTR              69.4
PRESS., ORIFICE  577
TEMP.,INLET              74.1
TEMP.,DISCH              331.4
DELTA P(V) IN. H2O                340
PRESS., INLET                557.5
PRESS.,DISCHARGE                1678.3
BARO.PRESS,IN.HG;AMBIENT TEMP.  30.26,70
DP NO.  P4/P1        EFF.       DEL T(C)/T1   RPM(CORR)
 46     2.95839      .75681      .482016      17782.4

PSI          CFM           PHI           HEAD       AIR FLOW
 7.82603      512.779       5.80556E-02    36871.1      24.267

MMSCFD        HP           RPM
 28.431       2215.59       18034.2
DP NO.  50
SHAFT SPD(COUNT)  9203
TEMP.,FLOW MTR              52.3
PRESS., ORIFICE  614
TEMP.,INLET              57.1
TEMP.,DISCH              317.8
DELTA P(V) IN. H2O                365.5
PRESS., INLET                600
PRESS.,DISCHARGE                1875.0
BARO.PRESS,IN.HG;AMBIENT TEMP.  30.2,57
DP NO.  P4/P1        EFF.       DEL T(C)/T1   RPM(CORR)
 50     3.07386      .753018     .50445       18054.7

PSI          CFM           PHI           HEAD       AIR FLOW
 7.89657      502.881       5.69597E-02    37171.1      26.4064

MMSCFD        HP           RPM
 30.9375      2442.78       18026.4
```

ure 6. Compressor Closed-Loop Performance Computer Analysis (Sheet 2)

SECTION 4

PACKAGE ACCEPTANCE TEST RESULTS

nce the major parts of the package were satisfactorily tested as individual com-
onents, the acceptance testing is designed as a final check to ensure the integrity
f the package systems and provide the customer an operational-ready unit.

.1 METHOD AND PROCEDURE

.1.1 Instrumentation

strumentation used during testing is calibrated and certified accurate in accor-
ance with a Solar-approved periodic calibration schedule.

.1.2 Acceptance Performance Test

he acceptance tests were conducted in accordance with Specification ES 1419C.
he following paragraphs form a brief outline of the acceptance specification.

tatic Electrical Check

his checkout was completed by manually simulating sensing device actuations by
losing various switches installed in parallel with the driven devices. Thus, the
odes of operation and malfunction protection were demonstrated in accordance
ith the test agenda.

restart Check

mechanism check of the package was conducted, including prestart flushing of the
ubrication and seal oil lines, calibration of instruments and controls, and actual
peration of the startup sequence to the point of starting the engine.

perational Check

he complete package was tested up to full power, with the engine power absorbed
n a hydraulic brake mounted on the end of the gas compressor and driven through

e compressor rotor. Thus, it was possible to run a full speed mechanical load d record conditions to detect any system leakage, and to check overall vibration vels and satisfactory subsystem operation. The compressor gas and seal oil stems were tested statically by pressurizing the compressor case to high pressure th nitrogen while sealing by means of the auxiliary seal pump. After the system as shown to be leak free, nitrogen pressure was reduced to the user's actual nditions, and a final adjustment was made to the seal oil pressure regulator.

gine Preservation

fter removal of all test gear, a final leak check was run, and the set was operated preserving oil and powder to ensure long term internal protection of vulnerable mponents and systems during shipment and storage.

he inspection stamp sheet in figure 7 attests functional package testing.

.2 RESULTS AND DISCUSSION

fter the package had satisfactorily passed the applicable tests as listed in the ceptance test specification, ES 1419C, and the test agenda for this sales order, e package was certified to be ready for customer delivery.

he dates the referenced package and its major components were tested and accepted re shown on the package performance acceptance certificate. (See figure 8.)

INSPECTION STAMP SHEET

PAGE 1 OF 1

...OMER MACHINOIMPORT SALES ORDER 2-06710 ES 1419C

... 12-14-1973 PACKAGE S/N 3020138 ENG S/N 3000241

...TION SUB	STD TIME	FUNCTION	INSP	OPERATION MAJ	OPERATION SUB	STD TIME	FUNCTION	INSP
10		Information Sheet	QCE 10	7600	350		Customer Integrated System Test (Yard Val...	QCE 10
20		Plan Conformance		7610	360		Engine Wash, Sys Test	
30		Verify Equipment	QCE 10	7610	370		Dual Filter Sys Test	QCE 10
40		Pre-test Service, Package	QCE 10	7610	380		Remote Load Control System Test	QCE 10
50		Preparing Package Lube & Seal Oil System	QCE 10	7620 7630	390 400		Package Sys Leak Chk Dyno Removal	QCE 10
60		Utilities Hook-up to Package	QCE 10	7640	410		Fuel Valve Failure System Test	QCE 10
70		Provisioning Electrical Hook-up	QCE 10	7640	420		System Low Voltage Malfunction Test	QCE 10
80		Instrumentation Hook-up	QCE 10	7640	430		Remote Start or Stop System Test	QCE 10
90		Dynamometer Hook-up	QCE 10	7640	440		Pre-Post Lube System Malfunction Test	QCE 10
100		Adjusting, Auxilliaries Systems	QCE 10	7640	450		Fail to Crank Malfunction Test	QCE 10
110		Adjusting, IGV	QCE 10	7640	460		Fail to Start System Malfunction Test	QCE 10
130		Limits and Correction Action	QCE 10	7650	470		Ignition Failure Malfunction Test	QCE 10
140 150		Pre-test Observation Non-combustion Crank	QCE 10	7650	480		Low and High Gas Press Malfunction Test	QCE 10
160		Starts, Five Successful	QCE 10	7650	490		High Oil Temperature Malfunction Test	QCE 10
170		Initial Start-up	QCE 10	7650	500		Low Oil Level Malfunction Test	QCE 10
180		Systems, Initial Operation	QCE 10	7660	320 330		Vibration System Malfunction Test	QCE 10
190		Overspeed System Test	QCE 10	7660	520		Kit Options	QCE 10
200		Low and High Oil Pressure Test	QCE 10	8000	530		Comp Slave Low Press Systems Removal	QCE 10
210 220		Low Speed Test Run High Pressure Air Start	QCE 10	7790 7800	540		Proof Pressure, Sys Instrumenting	QCE 10
250		Two Hour Load Run	QCE 10	8040	550		Proof Pressure Test	QCE 10
280		Speed Topping Test	QCE 10	8040	560		Proof Pressure Test Initial Phase	QCE 10
290		Governor High Speed Stop Setting	QCE 10	8040	570		Customer Level Pressure Test	QCE 10
300		T5 Temp System Malfunction	QCE 10	8040	580		Comp Discharge Press Switch System Test	QCE 10
310		T5 Topping Test	QCE 10	8080	590		Post Pressure Test System Dismantling	QCE 10
320		Seal Oil P Switch System Test	QCE 10	8120	600		Oper 500-B LoL Test & Test Dismantling	QCE 10
330		Comp Discharge Press Switch System Test	QCE 10	8140	610		Test Termination	QCE 10
340		Comp Discharge Temp Switch System Test	QCE 10	8160	620		Preservation Run	QCE 10

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Figure 7. Package Functional Test Verification

CENTAUR GAS COMPRESSOR SET
PERFORMANCE ACCEPTANCE CERTIFICATE
FOR

achinoimport, Moscow, USSR	50-32/40927	2-06710
CUSTOMER	CONTRACT NO.	SALES ORDER

SCRIPTION:

AGE SERIAL NO.	3020138	MODEL NO.	CSS-3168H
E SERIAL NO.	3000241	MODEL NO.	T-3002
OMPRESSOR SERIAL NO.	2344	MODEL NO.	C-1688-2510H
SPEED GEAR UNIT SERIAL NO.	109892	SIZE/TYPE NO.	206 HS

URBINE GREEN RUN TEST

formance Acceptance Approval 11-27-1973

OMPRESSOR TEST

formance Acceptance Approval 12-12-1973

AGE ACCEPTANCE TEST

kage Performance Acceptance 12-14-1973

AGE ACCEPTANCE APPROVAL

is to certify that this Gas Compressor Set was tested and that it complied e applicable requirements of Solar Specifications as defined in ES 1459E, 8B, and ES 1419C.

Production Engineer — M. W. Kohl — Date 12/17/1973

er tion Test — G. J. Keller — Date 12-17-73

Figure 8. Performance Acceptance Certificate