NASA TM X- 73957-4

NASA TECHNICAL MEMORANDUM

)

73957-4

×

NASA TM

)

Ċ,

(NASA-TM-X-73957-4) LARC DESIGN ANALYSIS N76-33555 REPORT FOR NATIONAL TRANSONIC FACILITY FOR 304 STAINLESS STEEL TUNNEL SHELL. VOLUME 4S: THERMAL ANALYSIS (NASA) 147 p HC \$6.00 Unclas CSCL 13M G3/39 07180

LARC DESIGN ANALYSIS REPORT

FOR

NATIONAL TRANSONIC FACILITY

FOR

304 STAINLESS STEEL TUNNEL SHELL

THERMAL ANALYSIS

VOL. 4S

BY

JAMES W. RAMSEY, JR., JOHN T. TAYLOR, JOHN F. WILSON, CARL E. GRAY, JR., ANNE D. LEATHERMAN, JAMES R. ROCKER, AND JOHNNY W. ALLRED

This informal documentation medium is used to provide accelerated or special release of technical information to selected users. The contents may not meet NASA formal editing and publication standards, may be revised, or may be incorporated in another publication.



Space Administration

Langley Research Center Hampton, Virginia 23665



1. Report No.	Z. Government Accession No.	3. Hecipient's Catalog No.
IM X-73957-4 4. Title and Subtitle LaRC Design Analysis Report for the National Transonic Facility for a 304 Stainless Steel Tunnel Shell -		5. Report Date September 1976
Thermal Analysis, Vol. 4S		6. Performing Organization Code
7. Author(s) J. W. Ramsey, Jr., J. C. E. Gray, Jr., A.	. T. Taylor, J. F. Wilson, D. Leatherman, J. R. Rooker,	8. Performing Organization Report No.
and J. W. Allred		10. Work Unit No.
9. Performing Organization Name and Address National Aeronautics and Space Administration Langley Research Center Hampton, Virginia 23665		
		11. Contract or Grant No.
		13. Type of Report and Period Covered Technical Memorandum X
National Aeronautics and Spa Washington, DC 20546	ace Administration	14. Sponsoring Agency Cade
16. Abstract This report contain	is the results of extensive comp	uter (finite element, fini
critical portions of a large Facility). The computer mod	e pressurized, cryogenic wind tu lels, loading and boundary condi	nnel (National Transonic tions are described. Gran
critical portions of a large Facility). The computer mod capability was used to displ A stress criteria is present analyses were performed for entire tunnel circuit is pre The major computer codes uti Systems, Inc. under NASA Con Langley Research Center and Structures Research Associat Heat-Transfer Computer Progr Center and described in NASA	e pressurized, cryogenic wind tu lels, loading and boundary condi ay model geometry, section prop ed for evaluation of the result major critical and typical area esented. lized are: SPAR - developed by stracts NAS8-30536 and NAS1-1397 described in NASA TN D-7179; an es under NASA Contract NAS1-100 am for Thermally Thick Walls" d NTM X-2058.	nnel (National Transonic tions are described. Grap erties, and stress results s of the analyses. Therma s. Fatigue analyses of th Engineering Information 7; SALORS - developed by d SRA - developed by 91; "A General Transient eveloped by Langley Resear
critical portions of a large Facility). The computer mod capability was used to displ A stress criteria is present analyses were performed for entire tunnel circuit is pre The major computer codes uti Systems, Inc. under NASA Con Langley Research Center and Structures Research Associat Heat-Transfer Computer Progr Center and described in NASA	<pre>e pressurized, cryogenic wind tu lels, loading and boundary condi ay model geometry, section prop ed for evaluation of the result major critical and typical area esented. lized are: SPAR - developed by stracts NAS8-30536 and NAS1-1397 described in NASA TN D-7179; an es under NASA Contract NAS1-100 am for Thermally Thick Walls" d TM X-2058. 18 Distribution Statemee</pre>	nnel (National Transonic tions are described. Grap erties, and stress results s of the analyses. Therma s. Fatigue analyses of th Engineering Information 7; SALORS - developed by d SRA - developed by 91; "A General Transient eveloped by Langley Resear
critical portions of a large Facility). The computer mod capability was used to displ A stress criteria is present analyses were performed for entire tunnel circuit is pre The major computer codes uti Systems, Inc. under NASA Con Langley Research Center and Structures Research Associat Heat-Transfer Computer Progr Center and described in NASA 17. Key Words (Suggested by Author(s)) Pressure Vessel Wind Tunnel Finite Element Numerical Integration Design	e pressurized, cryogenic wind tu lels, loading and boundary condi ay model geometry, section prop ed for evaluation of the result major critical and typical area esented. lized are: SPAR - developed by stracts NAS8-30536 and NAS1-1397 described in NASA TN D-7179; an es under NASA Contract NAS1-100 ram for Thermally Thick Walls" d TM X-2058. 18 Distribution Stateme UNCLASSIFIED	nnel (National Transonic tions are described. Grap erties, and stress results s of the analyses. Therma s. Fatigue analyses of th Engineering Information 7; SALORS - developed by d SRA - developed by 91; "A General Transient eveloped by Langley Resear
 critical portions of a large Facility). The computer mod capability was used to displ A stress criteria is present analyses were performed for entire tunnel circuit is pre The major computer codes uti Systems, Inc. under NASA Con Langley Research Center and Structures Research Associat Heat-Transfer Computer Progr Center and described in NASA 17. Key Words (Suggested by Author(s)) Pressure Vessel Wind Tunnel Finite Element Numerical Integration Design 19. Security Classif. (of this report) 	Pressurized, cryogenic wind tu lels, loading and boundary condi ay model geometry, section prop ed for evaluation of the result major critical and typical area esented. lized are: SPAR - developed by tracts NAS8-30536 and NASI-1397 described in NASA TN D-7179; an es under NASA Contract NASI-100 am for Thermally Thick Walls" d TM X-2058. 18. Distribution Stateme UNCLASSIFIED 20. Security Classif. (of this page)	nnel (National Transonic tions are described. Grap erties, and stress results s of the analyses. Therma s. Fatigue analyses of th Engineering Information 7; SALORS - developed by d SRA - developed by 91; "A General Transient eveloped by Langley Resear nt - UNLIMITED 21. No. of Pages 22. Price*

4 2

• For sale by the National Technical Information Service, Springfield, Virginia 22151

NATIONAL TRANSONIC FACILITY TUNNEL SHELL NASA - LARC

ζĢ.

)

•)

1.1

1.50

THERMAL ANALYSIS

304 STAINLESS STEEL SEPTEMBER 1976 VOLUME 4S

l

LaRC CALCULATIONS FOR THE NATIONAL TRANSONIC FACILITY

TUNNEL SHELL

DATE: SEPTEMBER, 1976

APPROVED:

amer W. Karnsey /2.

DR JAMES W. RAMSEY, JR., HEAD STRUCTURAL ENGINEERING SECTION

ANALYSTS:

)

)

JOHN T. TAYLOR

HEAD SHELL ANALYST

JOHN F. WILSON, SHELL WORK PACKAGE & CONSTRUCTION MANAGER

Anne D. LEATHERMAN

SHELL PROGRAMMER

W. ALLRED

SHELL/THERMAL ANALYST

CARL E. GRAY, JR.

Roken amer 1

JAMES R. ROOKER SHELL/THERMAL ANALYST

This report is one volume of a Design Analysis Report prepared by LaRC on portions of the pressure shell for the National Transonic Facility. This report is to be used in conjunction with reports prepared under NASA Contract NAS1-13535(c) by the Ralph M. Parsons Company (Job Number 5409-3 dated September 1976) and Fluidyne Engineering Corporation (Job Number 1060 dated September 1976). The volumes prepared by LaRC are listed below:

- Finite Difference Analysis of Cone/Cylinder Junction (304 S.S.) Vol. 1, NASA TM X-73957-1.
- Finite Element Analysis of Corners #3 and #4 (304 S.S.), Vol. 2S, NASA TM X-73957-2.
- 3. Finite Element Analysis of Plenum Region Including Side Access Reinforcement, Side Access Door and Angle of Attack Penetration (304 S.S.), Vol. 3S, NASA TM X73957-3.
- 4. Thermal Analysis (304 S.S.) Vol. 4S, NASA TM X73957-4.
- 5. Finite Element and Numerical Integration Analyses of the Bulkhead Region (304 S.S.), Vol. 5S, NASA TM X73957-5.
- 6. Fatigue Analysis (304 S.S.), Vol. 6S, NASA TM X73957-6.
- 7. Special Studies (304 S.S.), Vol. 7S, NASA TM X73957-7.



)

.)

NTF DESIGN CRITERIA FOR 304 STAINLESS STEEL

GENERAL

THE DESIGN OF THE PRESSURE SHELL REFLECTED IN THIS REPORT SATISFIES THE DESIGN REQUIREMENTS OF THE ASME BOILER AND PRESSURE VESSEL CODE, SECTION VIII, DIVISION 1. SINCE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN, ADDITIONAL ANALYSES WERE PERFORMED IN AREAS HAVING COMPLEX CONFIGURATIONS SUCH AS THE CONE CYLINDER JUNCTIONS, THE GATE VALVE BULKHEADS, THE BULKHEAD-SHELL ATTACHMENTS, THE PLENUM ACCESS DOORS AND REINFORCEMENT AREAS, THE ELLIPTICAL CORNER SECTIONS, AND THE FIXED REGION (RING S8) OF THE TUNNEL. THE DIVISION 1 DESIGN CALCULATIONS, THE ADDITIONAL ANALYSES AND THE CRITERIA FOR EVALUATION OF THE RESULTS OF THE ADDITIONAL ANALYSES TO ENSURE COMPLIANCE WITH THE INTENT OF DIVISION 1 REQUIREMENTS ARE CONTAINED IN THE TEXT OF THIS REPORT. THE DESIGN ANALYSES AND ASSOCIATED CRITERIA CONSIDERED BOTH THE OPERATING AND HYDROSTATIC TEST CONDITIONS.

IN CONJUNCTION WITH THE DESIGN, A DETAILED FATIGUE ANALYSIS OF THE PRESSURE SHELL WAS ALSO PERFORMED UTILIZING THE METHODS OF THE ASME CODE, SECTION VIII, DIVISION 2.

MATERIAL

)

THE PRESSURE SHELL MATERIAL SHALL BE ASME, SA-240, GRADE 304 FOR PLATE AND SA-182, GRADE F304 FOR FORGINGS. THE MATERIAL PROPERTIES AT TEMPERATURES EQUAL TO OR BELOW 150°F ARE AS FOLLOWS:

(A) PLATE

YIELD = 30.0 KSI ULTIMATE = 75.0 KSI

(B) WELDS (AUTOMATIC, SEMIAUTOMATIC, OR "STICK")

YIELD = 30.0 KSI ULTIMATE = 75.0 KSI

OPERATING, DESIGN AND TEST CONDITIONS

THE OPERATING, DESIGN AND TEST CONDITIONS FOR THE TUNNEL PRESSURE SHELL AND ASSOCIATED SYSTEMS AND ELEMENTS ARE SUMMARIZED BELOW:

1. OPERATING MEDIUM

ANY MIXTURE OF AIR AND NITROGEN

2. DESIGN TEMPERATURE RANGE

MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT, EXCEPT IN THE REGION OF THE PLENUM BULKHEADS AND GATE VALVES INSIDE A 23-FOOT, 4-INCH DIAMETER, FOR WHICH THE TEMPERATURE RANGE IS MINUS 320 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT.

3. PRESSURE RANGE

)

)

OPERATING DESIGN PRESSURE PRESSUR PRESSURES TUNNEL CONFIGURATION RANGE, PSIA PSID CONDITION I - PLENUM Α. ISOLATION GATES OPEN AND TUNNEL OPERATING: TUNNEL CIRCUIT 8.3 to 130 A. 8 EXTERNAL EXCEPT PLENUM B. 119 INTERNAL PLENUM (PLENUM PRESS- 3.3 to 130 A. 15 EXTERNAL URE IS LIMITED TO B. 119 INTERNAL .4 TO 1 TIMES THE REMAINDER OF THE TUNNEL CIRCUIT BULKHEAD 56 (EXTERNAL TO PLENUM) Β. CONDITION II - PLENUM ISOLATION GATES OPEN AND TUNNEL SHUTDOWN: A. 8 EXTERNAL ENTIRE TUNNEL CIRCUIT 8.3 to 130 B. 119 INTERNAL BULKHEAD n С. CONDITION III - PLENUM ISOLATION GATES AND ACCESS DOORS CLOSED: TUNNEL CIRCUIT EXCEPT 8.3 to 130 A. 8 EXTERNAL B. 119 INTERNAL PLENUM

V



PLENUM (PLENUM OPER-ATING PRESSURE CAN EXCEED THE PRESSURE IN THE REMAINDER OF THE TUNNEL CIRCUIT BY 24 PSI, BUT DOES NOT EXCEED THE 130 PSIA MAXIMUM OPERATING PRESSURE)

BULKHEAD

)

)

0 to 130

A. 15 EXTERNAL B. 119 INTERNAL

> A. 25 (INTERNAL TO PLENUM)

- B. 119 (EXTERNAL TO PLENUM) FOR MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT
- *C. 115.7 (EXTERNAL TO PLENUM) FOR PLUS 151 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT

B. 119 INTERNAL

0

*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

CONDITION IV - PLENUM D. ISOLATION GATES CLOSED AND ACCESS DOORS OPEN:

> TUNNEL CIRCUIT EXCEPT 8.3 to 130 A. 8 EXTERIAL PLENUM

PLENUM

14.7

BULKHEAD

A. 119 (EXTERNAL TO PLENUM) FOR MINUS 320 DEGREES FAHRENHEIT TO PLUS 150 DEGREES FAHRENHEIT *B. 115.7 (EXTERNAL TO PLENUM) FOR PLUS 151 DEGREES FAHRENHEIT TO PLUS 200 DEGREES FAHRENHEIT

*OPERATING PROCEDURES LIMIT PRESSURES TO THAT SHOWN.

vi

4. HYDROSTATIC TEST DESIGN CONDITIONS

THE PRESSURE SHELL WAS DESIGNED FOR HYDROSTATIC TEST IN ACCORDANCE WITH THE REQUIREMENTS OF THE ASME CODE, SECTION VIII, DIVISION 1. THE TEST PRESSURES SHALL BE AS FOLLOWS. PRESSURE SHELL TEMPERATURE SHALL BE EQUAL TO OR BELOW 100°F DURING HYDROSTATIC TESTS.

CONDITION (1) - MAXIMUM INTERNAL PRESSURE CONDITION FOR THE ENTIRE TUNNEL CIRCUIT

 $PH_1 = 1.5 (119) (\frac{18.7}{18.2}) + HYDROSTATIC HEAD$

= 183.4 PSI + HYDROSTATIC HEAD

CONDITION (2) - MAXIMUM DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

 $PH_2 = 1.5 \left(\frac{18.7}{18.2}\right) (119) + HYDROSTATIC HEAD$

= 183.4 + HYDROSTATIC HEAD

 $PH_2^* = 1.5 (115.7) (\frac{18.7}{17.7}) + HYDROSTATIC HEAD$

= 183.4 + HYDROSTATIC HEAD

*TUNNEL OPERATION LIMITATIONS PRECLUDE PRESSURE DIFFERENTIALS ACROSS BULKHEADS IN EXCESS OF 115.7 PSI FOR BULKHEAD AND GATE TEMPERATURES IN EXCESS OF 150°F.

CONDITION (3) - MAXIMUM REVERSE DIFFERENTIAL PRESSURE CONDITION ACROSS THE PLENUM BULKHEADS

 $PH_3 = 1.5 \left(\frac{18.7}{18.2}\right) (25) = 38.5 PSI$

THE PRESSURE SHELL EXCEPT FOR THE PLENUM SHALL BE PRESSURIZED TO 144.9 PSIG. THE PLENUM SHALL BE PRESSURIZED TO 183.4 PSIG.

PRESSURE SHELL STRESS EVALUATION CRITERIA

ે)

)

THIS CRITERIA ESTABLISHES THE BASIS FOR ANALYSIS AND DESIGN OF THE PRESSURE SHELL SO IT WILL MEET OR EXCEED ALL OF THE REQUIREMENTS OF SECTION VIII, DIVISION 1 OF THE ASME BOILER AND PRESSURE VESSEL CODE AND CAN BE STAMPED WITH A DIVISION 1 "U" STAMP.

1. SECTION VIII, DIVISION 1, DIRECT APPLICATION '

(A) THE MAXIMUM ALLOWABLE STRESS (S)

 $S = 18.2 \text{ KSI} (-320^{\circ}\text{F} \text{ TO} + 150^{\circ}\text{F})$

 $S = 17.7 \text{ KSI} (-320^{\circ}\text{F} \text{ TO} + 200^{\circ}\text{F})$

(B) PRIMARY BENDING PLUS PRIMARY MEMBRANE STRESSES

THE LOCAL MEMBRANE STRESSES ARE NOT GENERALLY CONSIDERED IN SECTION VIII, DIVISION 1 DESIGNS. HOWEVER, FOR THE PURPOSE OF DESIGNING LOCAL REINFORCEMENT AT BRACKETS, RINGS OR PENETRATIONS NOT COVERED BY DESIGN BASED ON STRESS ANALYSIS, THE LOCAL SHELL MEMBRANE STRESS SHALL BE:

 $P_b + P_m \leq 1.5 SE$

NOTE: E IS JOINT EFFICIENCY

2. IN REGIONS OF THE PRESSURE SHELL WHERE DIVISION 1 DOES NOT CONTAIN RULES TO COVER ALL DETAILS OF DESIGN (REF. U-2(g)), ADDITIONAL ANALYSES WERE PERFORMED UTILIZING THE GUIDELINES OF THE ASME CODE, SECTION VIII, DIVISION 2, APPENDIX 4, "DESIGN BASED ON STRESS ANALYSIS." THE BASIC STRESS CRITERIA FOR DIVISION 2 IS REPRESENTED IN FIGURE 4-130.1 AND RESTATED BELOW INDICATING ANY MODIFICATIONS OR EXCESS REQUIREMENTS APPLIED TO IT TO REMAIN WITHIN THE INTENT OF DIVISION 1 AND TO OBTAIN A DIVISION 1 STAMP.

A. GENERAL PRINCIPAL MEMBRANE STRESS

MAXIMUM ALLOWABLE STRESS

 $S = 18.2 \text{ KSI} (-320^{\circ} \text{F TO } +150^{\circ} \text{F})$

 $S = 17.7 \text{ KSI} (-320^{\circ}\text{F} \text{ TO} + 200^{\circ}\text{F})$

MAXIMUM ALLOWABLE STRESS INTENSITY

 $S_m = 20.0 \text{ KSI} (-320^{\circ} \text{F TO} + 300^{\circ} \text{F})$

B. PRIMARY GENERAL MEMBRANE STRESS INTENSITY

-vii/

$P_m \leq S_m$

AND IN ORDER TO COMPLY WITH DIVISION 1, THE MAXIMUM PRINCIPAL MEMBRANE STRESS MUST BE:

P**_* ≤** S

NOTE: THE * IS USED TO DENOTE THAT MAXIMUM PRINCIPAL STRESSES ARE TO BE COMPUTED FOR THE GIVEN LOADING CONDITION. THE INTENT IS TO DETERMINE THE STRESSES WHICH REPRESENT THE HOOP STRESSES AND MERIDIONAL STRESSES WHICH ARE THE STRESSES USED IN DIVISION 1 COMPUTATIONS. C, DESIGN LOADS, PRIMARY LOCAL MEMBRANE STRESS INTENSITY

 $P_{I_1} \leq 1.5 S_m$

.)

-)

)

- NOTE: LOCAL MEMBRANE STRESS INTENSITY IS DEFINED IN ACCORDANCE WITH DIVISION 2, APPENDIX 4-112(i). THE TOTAL MERIDIONAL LENGTH IS CONSIDERED TO BE 1.0 V RT.
- D. DESIGN LOADS, PRIMARY LOCAL MEMBRANE PLUS PRIMARY BENDING STRESS INTENSITY

 $P_{I} + P_{b} \le 1.5 S_{m}$

E. OPERATING LOADS, PRIMARY PLUS SECONDARY STRESS INTENSITY

 $P_{L} + P_{b} + Q \leq 3 S_{m}$

3. A FATIGUE ANALYSIS WAS CONDUCTED IN ACCORDANCE WITH SECTION VIII, DIVISION 2 WITHOUT MODIFICATION.

4. HYDROSTATIC TEST CONDITION DESIGN CONSIDERATIONS

A. PRESSURE SHELL

IN ACCORDANCE WITH DIVISION 1 OF THE ASME CCDE, DESIGN ANALYSIS OF THE PRESSURE SHELL FOR THE HYDROSTATIC TEST CONDITION IS NOT REQUIRED. HOWEVER, IN ORDER TO PROVIDE A SATISFACTORY ENGINEERING DESIGN FOR THE PRESSURE SHELL SPECIAL EMPHASIS WAS GIVEN, AS PROMPTED BY NOTE (1) OF SECTION VIII, DIVISION 1 OF THE ASME CODE, TO FLANGES OF GASKETED JOINTS OR OTHER APPLICATIONS WHERE SLIGHT AMOUNTS OF DISTORTION CAN CAUSE LEAKAGE OR MALFUNCTION. EXAMPLES OF THESE AREAS ARE THE PLENUM, PLENUM ACCESS DOORS, PLENUM ACCESS DOOR REINFORCEMENT, THE BULKHEADS, AND BULKHEAD FLANGES.

B. SUPPORT RINGS

DESIGN OF THE PRESSURE SHELL SUPPORT RINGS, INCLUDING

THE CORNER RINGS, FOR THE HYDROSTATIC TEST CONDITION, COMPLIES WITH THE FOLLOWING:

(A) THE COMBINED VALUE OF THE SHELL CIRCUMFERENTIAL PRESSURE STRESS, S, AND SHELL

BENDING STRESS S2, RESULTING FROM ACTION OF A

PORTION OF THE SHELL AS AN INNER FLANGE OF THE RING, SHALL NOT EXCEED 0.8 WELD YIELD STRESS:

 $S_1 + S_2 \leq 0.8$ WELD YIELD STRESS,

WHERE, FOR SUPPORT RINGS NOT ANALYZED BY FINITE ELEMENT TECHNIQUES,

 $S_1 = P_H \left(\frac{R}{T}\right) + .6 P_H; P_H INCLUDES HYDROSTATIC$

HEAD CORRECTION, AND

S, = RING BENDING STRESS AT INNER FLANGE, BASED

ON AN EFFECTIVE WIDTH OF THE PRESSURE SHELL ACTING AS AN INNER FLANGE OF THE RING OF 1.1 MULTIPLIED BY THE SQUARE ROOT OF D. T.

(B) THE BENDING STRESS, S_{2F} ON THE OUTSIDE FLANGE

SHALL NOT EXCEED .9 WELD YIELD STRESS. (IN THE COMPUTER ANALYSIS ALL LOADING CONDITIONS ARE LIMITED TO .9 Sy ON THE OUTER FLANGE.)

(C) BRACKETS AND SUPPORT PAD WELDMENTS

THE DESIGN FOR ALL LOADING CONDITIONS INCLUDING THE HYDROSTATIC TEST CONDITION OF THOSE PORTIONS OF BRACKETS AND SUPPORT PAD WELDMENTS WHICH ARE ATTACHED TO THE PRESSURE SHELL BUT NOT ON THE SURFACE OF THE SHELL SHALL COMPLY WITH THE REQUIREMENTS OF THE AISC CODE, I.E. MAXIMUM STRESS IN TENSION EQUALS .6 S_y, ETC.

X

ORIGINAL' PAGE IS OF POOR QUALITY

)

)

)

The enclosed analyses is for 9% Ni with a 6" Temp-Mat Insulation with internal circumferential "T" rings. The new baseline insulation is a closed cell material "Rohacell", with internal tabs. The "Rohacell" insulation reduces the stresses contained herein by a factor of 7.

19

 $(\hat{\mathbf{r}}_{ij})$

Xć

14

 \mathcal{D}_{i}

 (\mathbf{c})

13

)

ł

3

SUBACT LITE BREET NO. BY THERMAL ANALYSIS JOB NO. CHKD. BY____ DATE____

THERMAL ANALYSIS REPORT

- I STEADY STATE ANALYSIS OF _____I BULKHEAD
- I TRANSIENT ANALYSIS OF _____ZO BULKHEAD
 - ACCIDENTAL EXPOSURE OF ______ 32 SHELL TO LN2 OR GN2
- IN DEEP "T" RING



 $I\!I$

I STEADY STATE ANALYSIS

W. Burning

- E_OF

SHEET NO.

JOB NO ...

SUBJECT

DATE.

DATE

KD. BY_

1

OF BULK HEAD REGION.



COMPUTER PROGRAMS

SUBJECT

DATE

CHRD. BY DATE.

TEMPERATURES WERE CALCULATED WITH "A GENERAL TRANSIENT HEAT-TRANSFER COMPUTER PROGRAM FOR THERMALLY THICK WALLS". NASA TECHNICAL MEMORANDUM NO. [TM X-2058]

SHEET NO. Z OF

ION NO.

18. Abstract

1_

This program is a general heat-transfer program which employs a finite-difference method for the solution of temperature histories of one-dimensional, two-dimensional, or spherical systems. Options are available for heat input given in tabular form, computed from a trajectory, or computed from a temperature history given for a specific location. The types of heat exchange are: (1) conduction; (2) convection - with (a) given heat input, (b) heating due to skin friction with Van Driest equations, (c) stagnation heating with Sibulkin, Detra-Kemp-Riddell, and Cohen equations; (3) radiation-out; (4) air-conduction; and (5) joint conduction. The system configuration is specified by an arbitrary number of discrete elements and their interrelationships.

ORIGINAL PAGE IS OF POOR QUALITY

2- STRESSES WERE CALCULATED WITH

"SPAR" WHICH IS A SYSTEM OF COMPUTER PROGRAMS USED PRIMARILY TO PERFORM STRESS, BUCKLING, AND VIERATIONAL ANALYSES OF LINEAR FINITE ELEMENT SYSTEMS.

MANLIAL NO. EISI A2200 BY

ENGINEERING INFORMATION SYSTEM, INC. 5120 CAMPBELL AVENUE, SUITE 240 SAN JOSE, CALIFORNIA 95130

(408) 379-0730

I- STEADY STATE ANALYSIS OF BULKHEAD

JOB NO

THE STEADY STATE THERMAL ANALYSIS OF THE BULKHEAD (DRAWING NO. HAS BEEN CONDUCTED FOR GATE VALVES ORENED AND CLOSED

A- GATE VALVE OPENED WITH FLOW:

SUBJECT.

THIS STEADY STATE CASE EXISTS WHEN THE TUNNEL IS IN OPERATION WITH THE AERO-DYNAMIC LINERS CONNECTED TO THE BUCKHEAD AS SHOWN BELOW



WHERE !

DITE

CHKD BY DATE

h = HEAT TRANSFER COEFFICIENT IN REGIONS SHOWN T = TEMPERATURE OF GAS

SUBJACT____

SHEET NO. NO. OF

JOB NO.___

ASSUMPTIONS:

- 1- ASSUME LINER TEMPERATURE TO EQUAL TO GAS STREAM TEMPERATURE SINCE FLOW IS NEAR MACH 1 AT LINER AND HEAT TRANSFER COEFFICIENT WILL BE LARGE.
- 2- ASSUME h, 4 h₂ ARE LARGE. THE RESISTANCE OF HEAT FLOW THRU SURFACE FILM WILL BE SMALL COMPARED TO RESISTANCE OF HEAT THRU INSULATION. THEREFORE OUTER SURFACE OF INSULATION WILL BE SAME AS GAS TEMPERATURE.

BODVDARY CONDITIONS

BASED ON ABOVE ASSUMPTIONS, THE BOUNDARY JONDITIONS ARE SAME AS A/E SOUNDARY CONDITIONS AND SHOWN IN TABLE 1

HEAT TRANSFER COEFFICIENT WILL EXIST ONLY IN BLOCKS | THRU 6. AN EFFECTIVE COEFFICENT IS CALCULATED FOR THE OTHER ELEMENT.

EFFECTIVE THERMAL BOUNDARY CONDITION IS DETERMINED BY DIVIDING THE THERMAL CONDUCTIVITY BY THE INSULATION THICKNESS. FOR EXAMPLE: K = 1.47 Btr. - IN FT2-HR-OF + = 6 INCHES he = 4.726 × 10 -7 Bta

GEOMETRY

THE DIMENSIONS OF THE FINITE ELEMENT MODEL IS SHOWN IN FIGURE 1



BY_____DATE_____SUBJECT._____SHEET NO._____SHEET NO._____STOREST

و هار ها چه بعد اس این هم خاط ها ما به او ا

DETERMINATION OF HEAT TRANSFER COEFFICIENT AND GAS TEMPERATURE FOR COMPUTER PROGRAM.

THE COMPUTER PROGRAM WILL ALLOW ONLY ONE GAS HEAT TRANSFER COEFFICIENT AND ONE GAS TEMPERATURE FOR EACH ELEMENT. THEREFORE, THESE VALUES ARE DEFINED AS FOLLOWS:

 $h_{eff} = \frac{h_1 A_1 + h_2 A_2}{A_1 + A_2}$

$$T_{eff} = \frac{h_i A_i T_i + h_2 A_2 T_2}{h_i A_1 + h_2 A_2}$$

WHERE ,

ی بی از میکند. این هم میران میریم می که که که که که که می میکند که که می میکند. این از استیکی از این از مراجع از این این این میکند. از این این این میکند.

> H, A, T, ARE CONDITIONS ON ONE SIDE OF ELEMENTS

AND

h2 A2 T2 HRE CONDITIONS ON OTHER SIDE OF ELEMENTS

THESE VALUES ARE LISTED IN TABLE 1



BY_____DATE

SUBJECT

SHEET NO. OF JOB NO .__

DIMESIONS

ELEMENT NO.	LENGTH	WIDTH
1	6.5 "	4.0"
2	4.0	4.0 ["]
3	2.5	4.0 "
4	5.0	4.0"
5	5.0	5.0
6	5.0	5.0
n 1 − 1 − 1 − 1 − 1 − 1 − 1 − 1 − 1 − 1	11.657	3.0
8	20.001	3.0
9	5.309	3.0
10	2.721	2.438
11	16.985	1.375
12	11, 284	1.875
13	13.019	1.875
14	14.228	1.375
15	4.708	1.875
16	14.380	4.50
17	1.240	14.50
!8	24,00	1.0
19 - 19 - 19 - 19 - 19 - 19 - 19 - 19 -	18.0	1,0
20	130	1.0
21 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	1.24	7.25
22	1.24	12.08
23	5.38	1.24
24	1.24	1.24
25	5.38	1.24
a	2. <i>88</i>	4,50
27	3 .50	3,125
28 (1997) 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997	12.00	1.75
29 - 19 - 19 - 19 - 19 - 19 - 19 - 19 -	21.00	1.75
30	27.00	1.75

No. 14. 1. SHEETNO SUBJECT JOB NO CHIND. BY 1.1 TABLE TOP. FLOW BOUNDARY CONDITIONS HEAT TRANSFER ELEMENT GAS TEMPERATURE COEFFICIENT NO. 1. IN 2-SEC- "F) (°R 1.066 ×10-5 160 1 7.566 × 10-6 2 7.566 × 10-6 3 1.10 × 10-5 4 5.401 × 10-6 5 8.524 × 10-6 6 4.726 × 10-7-7 3 9 ID 11 12 13 14 4.726 X10-7 160 15 1.711 × 10-4 16 526 4.726 × 10-7 17 160 1.698×10-6 18 50.5 1.698 × 10-6 19 505 1.693 × 10-6 505 20 2.894 × 10-6 560 21 22 13 ¥ 24 2.394 × 10-6 560 _ 5 1.711 × 10-6 26 506 1.706 × 10-5 27 506 X 10-6 505 28 1.7 × 10-6 29 1.7 105 × 10-6 30 1.7 505



RESULTS

)

)

THE TEMPERATURE DISTRIBUTION WAS CALCULATED FOR THE MODEL SHOWN IN FIGURE 1. THE UPDATED MODEL, SHOWN IN FIGURE 2, SHOWS THE FINAL DIMENSIONS OF THE BULKHEAD. A COMPARSION WILL BE SHOWN IN THE TRANSJENT ANALYSIS THAT THIS CHANGE IN DIMESIONS DOES NOT EFFECT THE TEMPERATURES OF THE BULKHEAD SINCE THE HEAT TRANSFER COEFFICIENT IS LARGE "ENOUGH" TO GIVE UNIFORM TEMPERATURE IN THE FLANGE AREA.

THE TEMPERATURE DISTRIBUTION OF THE BUCKHEAD IS SHOWN IN FIGURE 3. THIS AGREES WITHIN 3° OF FLUIDYNE'S CALCULATED RESULTS SHOWN IN FIGURE 4.

THE STRESSES FOR THIS CASE WILL NOT BE CALCULATED SINCE THE TEMPERATURE GRADIENTS ARE NOT AS SEVEREAS IN TRANSIENT CASE SHOWN ON FIGURE 11. THE STRESSES HRE SHOWN ON FIGURES 12, 13, HND 14.

THE UPDATED CONFIGURATION OF THE TUNING-FOLK IS SHOWN IN FIGURE 5. THE TEMPERATURE WILL BE SIMILAR TO THAT SHOWN IN FIGURE 5 SINCE THE TEMPERATURE GRADIENTS IN THIS AREA HRE SMALL COMPARED TO THE INNER FLANGE. THE STRESSES IN THIS AREA ARE ALSO SMALL A. SHOWN IN FIGURES 12, 13, AND 14.

SHEET NO. L.OF. Salari Angela (1979) Kalani Angela (1979) Kalani Angela (1979) JOB NO UPDATE OF THERMAL MODEL OF BULKHEAD 13'-7," DIA. (163") 5 5 4 5" G 5 (4) 5 (199") 2.5 3 16'-7" 11.657 $\overline{(7)}$ 2 4 18" 5.5 8 4¹¹ ORIGINALI PAGE IS OF POOR QUALITY FIGURE 2









ASSOMPTIONS

E ASSUME h, + h. ARE LARGE, THERE-FORE THE SURFACES EXPOSED TO THE GAS ARE ASSUMED TO BE THE SAME AS THE GAS TEMPERATURE.

BHERT NO. 16 . OF

2- ASSUME TEMPERATURE OF GATE IS -100% (THIS ASSUMPTION IS CHECKED IN TRANSIENT ANALYSIS) SEE RESULTS FOR CHECK ON THIS ASSUMPTION.

BOUNDARY CONDITIONS:

THE STEADY STATE BOUNDARY CONDITIONS ARE AS FOLLOWS:

$$\int T_1 = -300 \,^{\circ}F$$
$$\int T_2 = 100 \,^{\circ}F$$

HEAT TRANSFER COEFFICIENTS FOR LINER IN CONTACT WITH GATE AND AERODVNAMIC LINER ARE LISTED IN TABLE 2.

RESULTS :

THE TEMPERATURE DISTRIBUTION IS SHOWN IN FIGURE 6. THIS GRADIENT IS LESS THAN THE FLOW DISTRIBUTION SHOWN IN FIGURE 3. THE TEMPERATURE GRADIENT THELD THE WALL THICKNESS IN NEGLIGBLE. THEREFORE THE THICKNESS THERMAL STRESS WILL BE SMALL. THE LOCAL GRADIENT AT THE GATE VALVE IS LARGER THAN THE FLOW CONDITION BUT



15

LESS THAN GRADIENTS SHOWN LATER FOR

THE TRANSIENT HEATING OF THE PLEMUM.

THE ASSUMED GATE TEMPERATURE OF

-100°F WAS INCORRECT. THE FINAL GATE

ANALYSIS IS -260 °F. THE TRANSIENT

TEMPERATURE AS SHOWN IN NEXT SECTION.

ANALYSIS WILL GIVE A MORE SEVERE

TEMPERATURE CALCULATED FROM THE THERMAL

WEJECT. 87 DATE SHORF NO. CHRD. BY____ DATE. JOH NO TABLE 2 NONFLOW THERMAL BOUNDARY CONDITIONS ELEMENT HEAT TRANSFER GAS NO. COEFFICIENT TEMPERATURE . IN = sec-oF) (Bth (°R) 1.0 × 10-3 360 1 2 360 3 360 4 439 5 560 1.0 × 10-3 6 560 4.723×10-7 7 360 8 7 .0 11 12 13 14 4.723 × 10-7 360 . 1.711 × 10-6 10 550 4.723 × 10-7 17 560 1.698×10-6 18 505 19 505 Ť 1.698 × 10-6 20 505 2.894 × 10-6 21 560 22 23 $\mathbb{Z} \mathcal{Y}$ 2.394 × 10-6 15 1.583 × 10-6 24 1.711 × 10-6 27 1.70 × 10-6 23 1.70 × 10-6 29 1.70 × 10-6 30 560



SHEET NO. SUBJECT____ DATE JOB NO. CHKO, BY____DATE

II_ TRANSIENT ANALYSIS OF BULKHEAD

IN ORDER TO CONSERVATIVELY BOUND THE TRANSIENT THERMAL STRESSES IN THE BULKHEAD, TWO CASES WILL BE INVESTIGATED

- A- THE FLOW MODEL WILL BE SUBJECTED TO A THERMAL SHOCK FROM 560 °R DOWN TO 160 °R IN 30 MINDTES,
- B- THE NOW FLOW MODEL WILL BE SUBJECTED TO A THERMAL SHOCK FROM STEADY STATE TEMPERATURES (FIGURE 3) UP TO 560 °R IN 30 MINUTES.

A. THERMAL SHOCK TO COOL BULKHEAD

THE MODEL & ASSLIMPTIONS ARE SAME AS FLOW CASE IN STEADY STATE CASE. THE -ETMETRY IS SAME ALSO AS SHOWN IN FULL IRE 1.





THE TEMPERATURE DISTRIBUTION CALCULATED IN THE TRANSIENT HEAT TRANSFER PROGRAM IS SHOWN IN FIGURE 7. THIS WORST CASE TO BRING PLEMUM DOWN TO TOO "R OCHRED AFTER 30 MINUTES FROM START OF COOL DOWN. THE MAXIMUM TEMPERATURE DIFFERENCE IS 346 "F BETWEEN ELEMENTS. (C) AND (T). THIS LARGE GRADIENT TEMPERATURE DISTRIBUTION AT TIME EQUAL TO 30 MINUTES WAS INPUT INTO "HE 'SPAR' PROGRAM TO CALCULATE THE RESULTANT STRESSES. THESE STRESSES ARE SHOWN IN FIGURE 8.




SY _____ DATE _____ SUBJECT _____ SHEET NO _____ OF

B- THERMAL SHOCK TO HEAT BULKHEAD

THE MODEL & ASSUMPTIONS ARE SAME AS NONFLOW CASE IN STEADY STATE CASE. THE GEDMETRY IS SAME AS SHOWN IN FIG. 1. THE INITIAL TEMPERATURE OF BULKHEAD BEFORE HEAT UP IS SAME AS STEADY STATE DISTRIBUTION WITH FLOW. THIS WAS SHOWN IN FIGURE 3. THE ASSUMPTION IS MADE THAT THE HEAT UP STARTS AS SOON AS THE GATES ARE CLOSED.



ORIGINAL PAGE IS OF POOR QUALITY DATE SUBJECT

SHEET NO. OF

RESULTS

Ì.

BY DATE

THE TEMPERATURE DISTRIBUTION FOR THE 30 MINUTE HEAT UP TIME IS SHOWN IN FIGURE 9. THIS MAXIMUM TEMPERATURE OCURRS AT 30 MINUTES AFTER THE START OF HEAT UP, THE TEMPERATURE DIFFERENCE IS LARGEST BETWEEN ELEMENTS (S) AND (D. (DT = 323 °F). THIS TEMPERATURE DISTRIBUTION WAS INPUT INTO. THE SPAR PROGRAM. TO CALCULATE MAXIMUM STRESSES (THERMAL AND PRESSURE). THE STRESSES ARE SHOWN IN FIGURE 10.

THE MAX. STRESS IS -51 KSI WHICH IS BELOW THE ALLOWABE OF 52.5 KSI. NOW, RERUN THE TEMPERATURE PROGRAM FOR A HEAT UP TIME OF 4 HOURS. THIS TEMPERATURE DISTRIBUTION WHICH GIVES MAXIMUM GRADIENT IS SHOWN IN FIGURE 11. THE MAXIMUM GRADIENT FOR THIS CASE OCCURS BETWEEN ELEMENTS () AND (). THIS CASE WAS INPUT INTO THE SPAR PROGRAM ALSO GIVING AN ACCEPTABLE STRESS VALUE OF -44 KSI. THE STRESS DISTRIBUTION FOR THE THIS THERMAL CASE AND 119 PSIG PRESSURE IS SHOWN IN FIGURES 12, 13 AND 14.

THE EFFECTS OF THE CHANGE IN THICKNESSES OF THE BUCKHEAD WERE CHECKED BY RE-RUNNING THE TRANSIENT HEAT TRANSFER PROGRAM. THESE THICKNESSES ARE SHOWN IN FIGURE 2. THE TEMPERATURES SHOWN IN FIGURE 15 ARE ALMOST EQUAL TO THOSE SHOWN IN FIGURE 11.















HEET NO. CHKD. BY____ DATE II - ACCENENTAL EXPOSURE OF SHELL TO LNZ OR GNZ A thormal strass analysis of the prosure shall between corner rings 56257 has seen conducted For the local loss of insulations of LN2 puddle. The thermal analysis indicates that the lord loss at insulation will drive the bare shill temp. to within 3° of LN2 tomps; therefore, the LN2 "puddle coold not impose any may squee gradient then this and it was not considered any father. The resulting thermal stress for love loss of insulation praked out (60,000 psi) for a 12' are of bare shell. These stresses were superimposed to existing stresses of typical structure rima and elliptical ring to determine reduction for Feligue life for this area

No= Number of operating eyels with Some

L =	Life year			
	LCFE			
Na	TYP TRUCT RING	E LLIPTICAL RING- WELD		
0	31	15		
1	21	15		
10	29	15		
50	$\frac{1}{25} = \frac{1}{25} $	14		
		a data da		

KO. BY DATE

Therefore othe local loss of insulation or LN2 puddh would affect the fatigue life of section of the tunnel differently. The important point is that this type of excident words to be defined before a lerge number of cycles are a roumulated.

Octail supporting calculations fillows.

ORIGINAL PAGE IS OF POOR QUALITY

BY	منها الله الإسكند بير ميد سو ه	DATE AST	SUB.
CHND. BY	r	DATE	، جند شور هن هو هر

JECT_

SHEET NO. 34 OF

ACCEDENTAL EXPOSURE OF SHELL TO LN2 or GN2

Two types of accidents can occur which would expose the shall to Live or GNZ

1. Loss of insulation this would expose shell to gaseous N2

2. Luz Puddle

DATE 35 SUBJECT SHEET NO. 3 OF CHRD. NY DATE I LOSS OF INSULATION The worse place to loose insulction is the region where is mouletion is the flow lime, and the flow has a high volderity. This occurs in the short log Setween corner rings 56 & 57. A FILM CODE Gas Film Corf. : The flow area changes in the short leg. The entrance has a 16 DIA AND them moleray an annulus in formal by the upstream Nacelle. Therefore, will calculate ans sucreya cort. Annulus ; Doz 20FL Di 10 Fr $A = \prod_{4} (20^{2} - 10^{2}) = 235.6271$ Aurrige A= 1/235.62 + 1162 = 218 Ft2 Assuma @ Trot Brothan M=1 RE= MD Po= 1 ATM (gives coldent To= -320"F Test soctions area := (2.5 m x 3,2802 Fg/m) = 67.27 FE² ORIGINAL PAGE IS OF POOR QUALITY

SUBJECT_____

2. A.

٠<u>.</u>

DATE

CHKD. BY____DATE___

BY,

ì

1

SHEET NO.	36 01
÷.	#
JOB NO.	ا منه منها جوار کور کې کو کې دو کې کو کې کو کې کو کې کو کې دو ول کې کو کې کو کې ک

$$\frac{1}{2} \frac{1}{2} \frac{1}$$

ORIGINAL PAGE IS OF POOR QUALITY

SHEET NO. DATE. BY___ CHKD. BY____ DATE B. THERMAL MODEL The short log will be used as the typical section to model. It will be assumed that a gration of insulation will be remound for the entire length of these SYMMETRY PLANE INSUL ATTOM REMOVED ANTAL STRIP OF Symmetry will be taken advantage of and the shill will be un wropped to Form a linner model. 26.13 T= 140°R HT= 2006th 18" K-W To= 100°F Hz= 1.5 Dtu Fi-hir.

CHKD. BY DAT C. COMPUTER INPUT The width of the insulation loss will be varied. The insulation will be tracted as an affictive Film coef. For modeling purposes and the shell will be divided into 30 Slocks (meximum the + program will handle LEN= 26117/30= ,87 ft or 10,47 iv WID= 167 in NOL: 17,01 For 1" the EFFictive Film Configuration -For a one Dimensional heat Salars on insulated plate ! $Q = T_0 - T_s$ LTAI KITAC OF POOR QUALITY For effective film confi-Q= heft Aft (TS-T2) helf Arcf = L + ET LIAT KTAL Neglecting curvature of shells. AI = AL= A

)

BY_____ DATE_____

)

SUBJECT_____

SHEET NO.

JOB NO.



For insulated shelli-

$$here = \frac{1}{1000} + \frac{18iN}{1000} \times 149iN^{2} Ft^{2} + \frac{15iN}{1000} \times 10^{-4} Btu$$

$$\frac{1}{1000} + \frac{1000}{1000} \times 10^{-4} F$$

For
$$A_i = A_0 = A$$

 $h_e FF = \frac{h_i + h_o}{2A} = \frac{h_i + h_o}{2}$

BY	BATE
CHED, BY	DATE

_ ___

نې د کې کې

١

SUBJECT_____

SHEET NO.	ang an ins
JOB NO.	

For the insulated blockst-
here =
$$\begin{bmatrix} 5:4349\times10^{-4} + 1.5 \\ -144 \end{bmatrix} = .005747 pt/
 $in^{2}hr^{*}F$
Tree = $\begin{bmatrix} (5:665740 + (.01092)560 \end{bmatrix} = 539^{*}$
 $2(.00599)$
For the uninsulated blockst-
here = $1:389 + .01042 = .7 \frac{B40}{in^{2}hr^{0}F}$
Tree = $(1:389 + .01042 = .7 \frac{B40}{in^{2}hr^{0}F}$
Tree = $(1:389)(140) + (.01042)(500) = .143^{\circ}R$
 $2(.7)$$$

BY_____DATE

)

TNELOLI

SUBJECT

SHEET NO. 972-OF JOB NO.____





7 LN2 PUOPLING

prosten than invalation loss. However, the resulting temperature distribution can be no worse than invalation loss because the bare shall trap, with No insulation is within 3° of the LN2 temps Therefore the results From the "insulafians loss" case will Sracket South of this accident proslems.



THERMAL STRESS IN SHELL H CLOSED FORM SOLUTION , A closed form solution will be used to estimate the thermal strass-s in the shorth 1- region of the shall. This repson will be modeled as a right circular cyl, with constant temp. thru the the and circumferential temp. Varietion. This type of temp. dist. will cause thermal strains in both the hoop and axed directions However, due to the Flaxibility of a third shell in the hoop direction (as compored to axial direction) the have strasses will be small comparate the in the exil characters, Therefore, many those Strisses in the exist disartion will be considered From $r \in 1$, $a \in [2\pi]$ $f_x = - \chi \in T(Q) + \sum_{\substack{2 \neq i \\ 2 \neq i \end{pmatrix}} \int_{0}^{2\pi} \chi T(Q) dQ + \sum_{\substack{2 \neq i \\ p \neq i \end{pmatrix}} \int_{0}^{2\pi} \chi T(Q) dQ$ $+E \cos \phi \left(\frac{2\pi}{\sqrt{100}} + \frac{2\pi}{\sqrt{100}} + \frac{2\pi}{\sqrt{100}} \right)$ The above equation is for MU constraint. The Second term is dropped for axial constraint.

SHEET NO

JOB NO.

and the last two are dropped for bending Constraint. These equations were programmed for 3 types of boundary Conditions: In completely constrained 3. NO Restraint 2 Bending restraint only

BATE III III IIII

CHKO. BY____ DATE____

PROVAND LAND STRS (INPUT, OUTPUT) + NOT DEDENSTON POTAL TEMP(100), SUMMIO), WKID COMMON R.H. EXTERNAL FALL

READ & E. ALPITA, PET, NTEND READ & TEMP

REHOX, A, Bilt, N

CALL SIMP (A, B, FX, H, N, SUM, WK, IERR) IF (IERR. N.E. O.) 60 TO 500 DO LO= I= J, NTEMP, 5 10 PH = I + H/R SIGXI= - ALPHAXE * TEMP(I) + E/PI * (Sum(1)/2,) + SDN (PHI) * SOM (2) + GOS (PHI) SUMB) THETA- 180, * PHE/PE PLINT *, THEJA, SIGK 10 CONTINUE

R=15.56

STRESSES

يليق دهم وفيقرد

```
山口が
   PRUGRAM (LA2STES) IMPUT, OUTPUT)
  DIMENSION SUNCIDI, MAR(12)
  CONTROL R. H. TEMP (61)
  EXTERMAL FX
  REND*, A, B, H, N, E, ALPHA, PI, HTEMP, P
  LEADS, TEMP
  CALL SIMP (A, B, FA) HALL SUMPARY IERES
  ("RINT*, SUM(1); SUM(2); SUM(3)
  17 12FF.ED.03 20,00
U PEDITE, LERE
0 10 10 I-1. NTEMP:1
  .I=I-1
   行用国主主要用对任
  SUGGERALPHAZER (-PIMICHPUI)-SIMIPHIDASLA(CORDANDA)
 () (10) (利用) 那就时(2)))
    出版的-1930、建筑方台1
  PERFORMANCE FRANKLER
J CONFIDE
  1.00
  1410
  ADPOUT TE THRAM
  DIMINISION FROM LONGING (DAY
  Athlur Path TENPISI)
  1713 #X/rt
  11-41-1-20
  ALL DETENDING /R
  THE REPAIR (PHI) ATEMP (TO 28
  MKI(S)-COS(PHI) #TEMP(N) /P
  FETURH
  LHD
ID OF FILE-
```

)

ORIGINAL PAGE IS DE POOR QUALITY



- PLUE (INFLMESTRS: URTR-LNEDAT)

1	
- 10 March 614 -5,89951631219 -109,	<u>[1804477</u>
N	
6.00.273691328 -201. 01100.10100200	
12.00254738386 -49. 12045.07653040	
18.00332107458 22. 846.2225565801	
pd_00509476611_533918.012613229	
00 00202045764 68 -6073,002973062	
30,00030040;04 00. 00.00.00100000000 Al Alanaijaijai 24 _4207 9518822754	
36.00/6421491/ 74. Totor.Cotocretion	
45.00031234669 110815.00102000 ~	
43.01018953222 736640.997720621	
54.01146322375 78. 6206.349336014	
A0 01073691528 79. 3392.589490344	
22 ALIALARARS 29 -5385-878462597	
56.0140100000 10. 000010 ST181925	
72.01028429833 (7. H4031.C) 101.CO	
78.01655798986 /94294.69610(4)	
84.01783168139 793722.17603734	· · ·
-90.01910537292 793140.012320777 -	
ac apus7906444 792554,585911173	
100 001652756 79, -1972 31358937	
104.041004.00 .00 .00 40.4008.000	
193.0227204464 17, 72, 74272,011072010	
114.024200139 79844.0004000000	
128.0254738386 79307.8013433753	
126.0267475221 79. 199.0697964872	
142 0280212136 79. 673.4492925214	
100 0000044061 29. 108.732727847	
100.000000001 (1. 1990 828373329	
, lak pologoologi (t. tooota opoi soota)	
108.83.34dd3dd f7. iofu.ediioioco	
156.0331159797 79. 2138.389920397	
162.0343896712 79. 2376.760000466	
168.0356633628 79. 2558.021207431	
172 H369376543 79, 2680,081365072	
100 anaprozzna 70. 2741.6110917	
- 1859-1879-099-000 TO - 1879-899-99-99-99-99- - 1859-1879-99-99-99-99-99-99-99-99-99-99-99-99-9	
192,0407081269 79. 2001.002400000	
198.8428313284 .74. 2007.642644444	
204.0433955113 .9. 2378, 49.0067603	
2.8.8446792805 73.12141.128051343	
216 065652745 79. 1348.639934836	
- 5-0 A.P. MARAAS 79. (AB4.734781936	
- ALE CHARTER AND	
ությունը հետևապետերությունը, և դերը չերը է հարցերությունը։ ԱՄՆԴԴՈՒԳՐԻԳՐԻԳՐԻԳՐԻՅՆԴԴՈՐԻ է չերը դերը երանագորվել հարցերությունը։	
2월42월4월66월2월9월8월 2월24월 2018년 2018년 4월28일 2019 2월24일4월16월2월2월2월 2월 2월24일 2018년 2	
- 200.00090756011 (24.0499.00049209049);	
246.3522213526 79382.1411360 1	
202.0204028442 79836.86886.84	
- 246. US47687357, 77 1393. 58233 (753	
5.4 0566424272 79 1966.183466047	
000 00001010100 200 ~2548.088878834	
- AND AND STOLIDE TO LOT A REACTING AND	
- 21210000000000000000000000000000000000	
- 232.0193630010 (**********************************	
208.061137193335. 4288.701961117	
- Sud Decalhered List dealer again and	
(1) 3001000303495464 (1)34 (400004,04386161530)	
- 306.0649582679 73. ~ 30007.077432841	
312.0662319594 13 5201.520090133	
118 BEZERBERT 13 636.611436698	
and a second second The second se	
สารณ์สายเสียงสาวที่สาว หลังสาวที่สายและได้	
1 336.9713267256 686079.138528991	
340 0726004171 533915 79199514	
	- .
- DAR DIGALISTAN (* 1920). (R.1990, 1983941)	J j
ALLERIE EURIPEILE ENTITE	

า เป็นสาวประกันใจ มาประเทศนี้และประสุด และสุดิทราศาสติเทศ กลั

Children Harris 11. Julie 1044 -5. 39931631219 -109. 19044774 17

DRIGINAL PAGE IS DE POOR QUALITY

Bending

coust orst.

No Constraint 1. block

. 492

1

OLD-PUN2 (IMPLN2sTRS; DRTHPLN2DRT2)

1. 1. 1. 0.0 1217837155 -14.3228292328 -265.2244467356
-317. 42743.42886269
aa1273691523 -317. 42741.13914835
0 00254739306 -316. 42727.08781836
10 00000107458 -207. 25633.00126708
0.0000010 -49, 366.2453326179
-9985.939522684
00724014917 5314,26.32650222
35.0070421471, 00.
42.00071334007 7415704.43733438
46.010107000000 77 -15135.07719706
59.01146522515 72 -14153.53809019
60.012/3691026 70 -12931.82680669
66.0140106005 10. 111802.33433294
72.01028422000 79 -10460.18910144
78.01600796966 79 -9029.602151482
84.01/33166132 72 -7675.795873888
90.01910537292 77. 1010. 898143949
96.0203/306444 731059 62368314
182.021652756 779479 394393563
108.0223264470 77. 03476.070695036
114.324230109 /92130.010000000
120.0254738306 79
126.0267475221 79. 370.0260,000
132.0280212136 79. 1341.036523000
138.0292949051 71. 2072.100046900
144.0305685967 79. 3017.9666666666
150.0318422832 79. 4349.007434517
106.8331153797 79. 0000.172060004
162.8343896712 79. 0631.700270402
168.0356633628 79. 0809.299902040
174.0069370543 79. 6364.107230799
180.0382107458 79. 0513.04340/07.5
186.0394844374 79. 6014.340323080
192.0437581289 79. 6368.0193880070
03.0420313204 73, 6070.0370303150
210433055119 79. 3640.551020(71
A A 445792035 79. 5067.379267202
218.045852895 79. 4362.45355666
222.0471265365 79. 0533.50096974
228.0434002781 79. 2583.60752313
2 44.0496739696 70. 1541.119838333
0.01.0009476611 79. 399.5273538243
ALL DE20213526 79822.6533602603
5-2 A134950442 792112.827833063
Act 1517687357 793454.46373573
574 Nr.60424272 794835.246045153
274 017161137 796239.241723000
The messeeping 797651.060306637
201.0011271933 7913436.35260351
10. 001100 08849 7911779.29734738
200 0 20245764 7912909.04175458
0010.00000404079 7814132.84594247
500.004 001 9594 7715115.90475922
007505651 7415686.99480203
0.022293425 6815675.11163332
0.11.000000031 5314112.09510009
53. m 5/8 2256, 229874.747529785
515 172 004171 -49, 375,076323713
ALL ATTOMATORE -207. 25639.37436173
25. 0751072001 -316. 42730.9332042
204.01014.0017 -317, 42742.47463258
NER A COUTED COED.
ILLEGAL CONTRACTORIES

ORIGINAL PACE IS

No constr 3 Slork,

494

)

)

)

-PLN2 (IN=LN2STRS, DATA=LN2DAT3)

-772.3951380792 -41.60772679233 -733.95665198
03173863.012122174
6.001273691528 -3178865.738333207
12.00254733306 -3178432.173036031
18.00382107438 -3177567.068469894
24.00509476611 -3176279.903906333
30.00636845764 -3174584.736715513
36.00764214917 -3172500.817726671
42.00891584069 -31749.31757759813
49.01018953222 -317. 2741.33371463
54.01146322375 -317. 5841.063216767
60.01273691528 -317. 9215.880348795
66.0140106068 -317. 12328.79928478
72.01528429833 -317. 16640.21940334
78.01655798986 -317. 20608.36434366
84.01783168139 -316. 24530.23990946
90 01910537292 -207. 11294.61080184
nc a2032906444 -499733,500044333
192 021652756 2216907.85789497
109 0229964475 5317770:42488704
114 624200139 6816193.95142949
129 0254738396 7413338.44879984
124 8267475221 7710202.68131182
100 0200012136 78 -6985.788280379
100 0292949051 783384.269304644
144 0305685967 791251.121128082
150 0318422832 79, 1202.047977359
156, 0331159797, 79, 3288,848722514
162.0343896712 79. 4986.403019783
168, 8356633628 79, 6276, 119195931
174.0369370543 79. 7143.845935137
180.0332107453 79. 7530.077224571
186.0394844374 79. 7580.031603471
192.0407581289 79. 7143.709571088
198.8420313204 79. 6275.393535179
204.0433055119 79. 4986.095634335
210.0445792035 79, 3288.452936536
216.045852895 79. 1201.573228869
222.0471265865 791251.669636437
228.0484002781 783884.086159704
234.0496739696 786936.465676375
240.8589476611 7718283.41232332
246.0522213526 7413339.21741555
252.0534950442 6816194.75513544
258.0547687357 5317771.26076633
264.0560424272 22. 18908.01371888
270.0573161187 -499731.379377-20
276.0585898103 -207. 11293.74049890
232.0598635013 -316. 24523.3737615
203.0611371933 -317. 20607.02261929
204.0624108849 -317. 16653.4005055
300.0636845764 ~317. 12626.06233174
306.0649382679 -317, 2213.142001041
312.0662319394 -317. 3340.30010314.
313.06/000601 -011. 1140.12100004
024.008/199420 -511
001 07:0000004 -011. L0001 11:000
242 0720004171 - 317, -6280, 218751107
210 0722741026 -317, -7567, 293521429
254 0751478001 -317, -3432, 383327483
350.0764214917 -3178865.783376189
THEFORE CONTROL LORD.
A hashed with the standard to the standard and the standard and

)

ORIGINAL PAGE IS OF POOR QUALITY

No constr 15 Storks



	1	10.000	
	262 0.10200101	1 200	
1224	DID COMPLECE()	5 Zola	motor, serus cel
	312.0662319594	184	-6201.528090133
	318.067505651 7	8	-6636.611436808 /
	324.0687793425	77.	-6868.858194519
1915	330.070053034 7	4	-6734, 474490277
	226 0713267286	68	-6070 199520901
	010 070 001171	50.	2015 70100514
	342.0726004171	0.04	-3910.79169014
	348.0738741086	cc.	847.8251996648
	354.0751478001	-49.	. 12050.64539184
	360.0264214917	-297	7. 37190.50239413
	LICCH CONTROL	1 00	ach
	ILL.COME CONTRO	1 L.F	W.L.*
	AUTO AUTO AUTO	Les TF	(S) DRTHELL LOPITY
	2. Se de		
	Jul	-3.	.39951631219 -109.9804477497
	0315. 60000.	6.543	37345
	6.00.273691528		2. 48774.65437345
	15 64051790562	E han	17570 15, 27045
	12.002099.00000		
	18.00082197458	EE.	6249,104373447
	00503476611 53.	136	34.654373447
	30.00636845764	68.	-1087.845626553
	36.00764214917	71.	-2044.845626553
	40 1000 804040		-1500 545204550
	46.00031034965	1.1.+	
	48.01018993222	18.	-2082.845626503
	54.01146322375	78.	-2682.045626553
	60.01273691528	79.	-2242.345626553
	cc 0 1010c0c0 7		0010 045202550
	00.0190100000 /		COME. CHOCOUD
	72.0.528429833	12.	-2842.343626003
	78.41.655798936	79.	-2842.345626553
	84 HT 123162139	29.	-2842.345626553
	20 11 1 0507000	20	
	201010100000000	1.24	
	26.02037206444	13.	-2842.340666003
	102.021602756 7	·9. ·	-2842.345626353
	108.0229264475	79.	-2842.043626553
	114.024209139 7	·	-2342.045626553
	100 0051700002	20	
	120.0207100000	20	
	160.060.410661	12.	
	lat. desdeleist	Set.	-d84d.3406d500d
	108.0202949851	79.	-2842, 343636333
	144.0335685967	79.	-2842.045620558
	152.2312422832	79.	-0842.045025353
	16.1 6001180707	-0	
	100.0001100101	1 4.4	
	166.0040070/16	1 0 4	
	les.u.possidedi	1.7.	- <u>2</u> 842.340020033
	174.0369370543	79.	-2842.345620553
	100.0332107458	79.	-2842.345626553 🚄
	1 00004844374	73	-2342.343323533
	000 10.175.01 200	29	-2012 245026552
		1	
	1 NOT THE REPORT OF STREET	1 2 4	
	E.G. M. S.S. Statute 1 4		20403040000000
	210.0445792035	1 1 .	- 2342.340520003
	210.040502895 7	·	-2042.340026056
	222.0471265365	14	-1342.345670553
	220 008-002291	22.24	2342.3453.2353
	and the second second	2.	2010 200 200550
	Electric des des distriction	1 - 4	 Restar Theorem and Construction Statement of the Statement of the Statement
	210.0509476611	1 2 4	್ರವರ್ಷ. ಮೇಲೆ ಗೂಪಡೆಯುವ
	246.0522213526	7.3.	-2842.341626553
	252.0534956442	29.	~2842.315626563
	202 0002697357	23	-2842 34563553
	Protocol a strate of a strate of a	1	
	CELCA 0.1070 70	11.1	
	0560-24272 79.	-23	
	0568-24272 79. 270.9573161137	79.	-2842.345626553
	0566-24272 79. 270.0573161137 276.0585898183	-28. 79. 79.	-2842.345626553 -2842.345626553
	0566-24272 79. 270.0573161137 276.0585098103 202.0598635018	-28 79. 79. 79.	-2842.345626553 -2842.345626553 -2842.345626553
	0560-24272 79. 270.0570161137 276.0585698103 202.0598635010 203.0511371935	-23 79. 79. 79. 79.	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553
	0560-24272 79. 270.9573161137 276.0585698103 202.0598635018 203.0611371935	-28 79. 79. 79. 79. 79.	2842.345626553 2842.345626553 2842.345626553 2842.345626553 2842.345626553
	0560-24272 79. 270.9573161137 276.0585698103 202.0598635018 203.0611371930 204.0624108849	-28 79. 79. 79. 79. 79. 79.	2842.345626553 2842.345626553 2842.345626553 2842.345626553 2842.345626553 2842.345626553
	0560-24272 79. 270.0570161137 276.0585698103 202.0598635018 203.0511371935 204.0624108849 300.0606845764	-28 79. 79. 79. 79. 79. 79.	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635013 203.0511371930 204.0624108849 300.0656845764 306.0649562679	-28 79. 79. 79. 79. 79. 79. 79.	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635013 203.0611371930 204.0624108849 300.0606845764 306.0649562679 312.0662319594	-28 79.79 79.79 79.79 79.79 79.79	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553
	0560-24272 79. 270.0570161137 276.0585698103 202.0598635013 203.0611371930 204.0624108849 300.0606845764 306.0649562679 312.0662319594 316.067505651	-28 79. 79. 79. 79. 79. 79. 79. 79. 78.	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.845626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635013 203.0611371935 204.0624108849 300.0636845764 306.0649582679 312.0662310594 313.067585651 3	-28 79.79.79 79.79 79.79 79.79 79.79 78.77	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.845626553 -2682.845626553 -2682.845626553
	0566-24272 79. 270.0573161137 276.0585698103 262.0598635018 263.0611371935 254.0624108849 300.0636845764 306.0649562679 312.0662319594 315.067505651 3 324.0687793425	-28 79.79.79 79.79 79.79 79.79 79.79 78.77	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.845626553 -2682.845626553 -2682.845626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635018 203.0611371930 204.0624108849 300.065845764 306.0649562679 312.0662310594 316.067505651 324.0687793425 330.070053834	-28 79.79 79.79 79.79 79.79 79.78 78.77	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.045626553 -2682.845626553 -2692.845626553 -2692.345626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635018 203.0511371930 204.0624108849 300.0656845764 306.0649562679 312.0662310594 310.067505651 324.0687793425 330.070053034 336.0713267256	-28 79.79 79.79 79.79 79.78 78.77 78.77 68	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.045626553 -2682.045626553 -2682.045626553 -2523.345626553 -2044.045626553 -2044.045626553
	0566-24272 79. 270.0570161137 276.0585698103 202.0598635018 203.0511371930 204.0624108849 300.0656845764 306.0643562679 312.0662310594 310.067505651 324.0687793425 330.070053034 336.0713267256 342.0726004171	-29. 79.79.79.79.78.77.88.80 79.79.79.78.77.88.77.88.80	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.345626553 -2682.345626553 -2682.345626553 -2694.345626553 -2044.345626553 -2044.345626553 -2044.345626553
	0560-24272 79. 270.0570161137 276.0585698103 202.0598635013 203.0611371930 204.0624108849 300.0656845764 306.0649562679 312.0662319594 310.067505651 324.0687793425 330.070053034 306.0713267256 342.0726004171 348.0733741086		-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.045626553 -2682.045626553 -2692.045626553 -2044.045626553 -1087.015626553 -1087.015626553 -2044.045626553
	0566-24272 79. 270.0570161137 276.0585698103 262.0598635018 263.0611371935 204.0624108849 300.0656845764 306.0649562679 312.0662319594 310.067505651 7 324.0687799425 336.0713267256 342.0726004171 348.0736741086		-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.845626553 -2682.845626553 -2682.845626553 -2692.845626553 -2692.845626553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.84566553 -2694.8456555 -2694.8456555 -2694.8456555 -2694.8456555 -269555 -
	0566-24272 79. 270.0570161137 276.0585698103 262.0598635018 263.0511371930 204.0624108849 300.0636845764 306.0649562679 312.0662319594 310.067505651 324.0687793425 336.070053034 336.0713267256 342.0726004171 348.0733741086 354.0751478001 360.0764214917	-29. 79.79.79.29.79.77.8.77.8.8.3.2.496 20.20.20.78.77.8.8.3.2.496	-2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2842.345626553 -2682.845626553 -2682.845626553 -2684.845626553 -2844.845626553 -1937.845626553 1304.04373447 6249.134373447 6249.134373447 6249.134373447 6249.134373447 52549.134373447 52549.134373447 52549.134373447 52549.134373447 52549.134373447 52549.134373447 52549.134373447 52549.134373445 52549.134373445 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.13437345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52549.1345 52555 52549.1345 52555 52549.1345 525555 52555 525555 52555 525555 525555 525555 525555 52555555 525555 52555555 5255555 5255555 5255555 525

NET.

Broding constant, 1Block

A A A A

-PLNELINFLMESTRSHORTH-LN2DFT21

and the second second

1. 0. 0.
222.4717887155 -14.3228292328 -265.22444673
0317. 56208.99860741
6.001273691528 -317. 56208.99850741
12.00254738306 -316. 56049.49860741
18.00382107458 -207. 38668.99860741
24.00509476611 -49. 13462.99860741
30.00636845764 22, 2138,498607412
36.00764214917 532806.001392588
42.00391584069 685198.501392588
48.01018958222 746155.501392388
54.01146322375 776634.001392588
60.01273691528 786793.501392588
66.0140106068 736793.501392588
72.01528429833 796953.001392588
78.01655798986 796953.001392588
84.01783168139 796953.001392588
90.01910537292 796953.001392588
96.02037906444 796953.001392588
102.021652756 796953.001392588
108.0229264475 796953:001392588
114.024200139 796953.001392588
120.0254738306 796953.001392588
126.0267475221 79. ~6953.001392588
132.0280212136 796953.001392588
138.0292949051 796953.001392588
144.0305685967 796953.001392588
150.0318422882 796953.001392538
156.0331159797 796953.001092588
162.0343896712 796953.001392588
168.0356633628 796953.001392588
174.0369370543 796953.001392588
180.0382107458 796953.001392588 🔫 🚽
186.0394844374 796953.001392588
192.0407581289 796953.001392588
198.0420318204 79. ~6953.001392588
204.0433055119 79. ~6953.001392588
210.0445792035 796953.001392588
216.045852895 796953.001392588
222.0471265865 79. ~6953.001392598
228.0484002781 736353.001392300
234.0496739696 796953.001392088
240.0009476611 796953.001392003
246.0522213526 /9. ~6953.001392538
252.0034950442 796953.001392088
258.0547687357 746953.001322368
264.0000424272 796703.001332066
2/0.00/316113/ /9. ~6903.001382000
276.0585898103 796903.001392008
202.0096530018 /9. ~5703.001376000
288.06113/1933 //6703.001320063
294.0624108849 79. 15903.001072000
300.0535545754 78. ~5775.001352056 567.67.0555575 705795 581292529
010 0(20010501 77
010 0.7505251 21
004 0/07700405 KS -5198 501092500
200 070052031 52 -2806.001232528
and 0710027052 00 0108 dr0207412
512 0726004121 -49 13462 49860741
0.0720741096 -207 30663,99960741
254 0751478001 -316, 56049, 49860741
360 0764214917 -317, 56208,99860741
TILEGAL CONTROL CARD.

ORIGINAL PAGE IS OF POOR QUALITY

Brading Constraint 351015

CLEAR NOITHEINESTRENDATAELNEDATO
-PLNC (111 Crass) 203 0566519817
1. 0. 0.
-172. 3901300124 00504213
0317. 30,35. 033 20938. 33534713
6.001273691528 -317. Sooge 93534713
12 66254738306 -317. 50000 02594713
10 00000107458 -317. 30438.00007149
18.00000176611 -317. 30938.83334(10
24.0000 - 10011 -317, 30938.8353+113
30,00030343754 317 30923,83534713
36.00764214917 317 30000 83534713
42 00291584069 -317. 38730. 39534713
10 01012953222 -317. 30930.00001113
40.010100000375 -317. 30938.03034110
54.011400000 -317, 30938.83534/10
60.012/3691360 317 20938.83534713
66.0140106068 -311 20938, 83534713
-72 A1528429833 -317 - 00000 02534713
70 01655798936 -317. 30930,00001112
78.01000120139 -316. 30779.33034710
84.01/00100102 -207. 13393.83534/10
90.01910337696 40 -11207.16465287
95.02037306444 -47. 00121 66465287
102 021652756 2220131.0010465287
100.0009264475 5320070.10400007
100.00000000000 6830468.66465287
114.024200107 74 -31425.66465237
120.0254738300
126.0267475221 (1. 00000 46465287
100 0230212136 7832063.001005.007
100.0000949051 7832003.00400000
100.0010 796967 7932223.16460207
144.03030000 29 -32223.16465287
150.0313422302 703223.16465287
156.0331159797 13. 000000 16465287
149 0343896712 7932200.101425987
100.000
160.00000000000000000000000000000000000
174.0365671040 79 -32223.16455267
180.0382107400 10
196.0394844374 21 55552 17465287
1 10. 1407581289
10 04-9318204 7932223.107050207
100.0100005119 70. 32223.10460101
201.040000011 79 -32223.16460207
210.0440792000
216.040852870 (2: 55559 16465287
500 M471265865 79. TOLLAT 22445987
555 1. 04002781 7832065. Competence
CLUS 01 10 724, 4, 78, -32005.00403.00
2.1.1.1701072231 7731904.16400201
2.0.0.000000000000000000000000000000000
206.0002213099
was up 17687357 53 Cod. 5. 10 10 10 10 10
C. 1 0500424272 2223131.00+00001
201.000000 1107 -14, -11897.10400C01
270,000 2101100 344 19303.33503723
276.0525898102 7601 - 63774.13534713
p
THE MEL 1371933 -31/ . CHANNEL 10534713
L. M. COL 1. 5764 -317. 30938.333301113
300.0600040104 -317, 30333.03034713
300.0641900dbr 2 517 25933,83334713
312.0662319534 511
213.067505651 -317. 30333.00521713
ANT 0012793425 -317. 30338.00000112
024.000413034 -317. 30938.83034113
330.07000000756 -317. 30938.83534713
336.0713207230 -317 30938.83534713
342.0726004171 017 00039.33534713
348,0738741086 -311. 50000 00134713
354 4751478801 -317. 30735.00501213
20 0764214917 -317. 30930.0000 H 10

)

)

)

Bried

15 Slorks

ILLEGAL CONTROL CARD.



HOR I TELLIS (THAT NESTRS, DATA=LN2DAT)	
The Albert of the same and the same	
DEL JEGGA	
M1 L140000.	
-PLNC	
SCHLLIPLIK.	
GET, PLNE	
/LISTNF=PLNC	
GET. III.	
GET. INTA.	
AF: OFF.	
Thi Latit. 1 =20	
TTOCH STUM TRAUES IBPREY)	
DOFT A TOWNER ON CANADA	
DOLIGER (CID-F (MILID)	
GU (DH (H)	
/-PLN2 (INFLN2STRS, DATH "LN2DAT)	
0315. 50242.5 -	
6.001273691528 -207. 33016.5	
12,00254733306 -49. 7815.5	
18 00382107458 223509.	
21 00509426611 538453.5	
29.00000110011 00 -10846	
30.00000000000 00. 10010.	
36.00/64214711 (4. 11000.	
42.00891089009 1112201.0	
48.01018953222 /81441.	
54.01146322375.7312441.	
60.01273691528 7912600.5.	
66.0140106068 7912600.5	
72.01528429833 7912600.5	
20 01655793986 7912600.5	
0. 61722169129 79 -12600.5	
00.0100100100100 -12600.5 -	
90.0191003729C 194 79 -10600 5	
96.02037906444 7512000.0	
102.021602/06 /912000.0	
108.0229264475 79, -12600.5	
114.024200139 7912600.0	
120.0254738306 7912680.5	
126.0267475221 7912600.5	
132.0280212136 7912600.5	
133 0292949051 79 2500.5	
14 0005685967 79. P600.5	
104.000000000 70 -12600 5	
100.00104E200E 10. 10000.0	
100.0001100707 70. 10000.0	
162.0343896716 (7. T10000.0	
168.0336633626 /912000.0	
174.8069370543 7912600.0	
108.0332107458 7912600.0 -	
186.0394844374 7912600.5	
192.0407581289 7912600.5	
198,0420318204 7912600.5	
203 033055119 7912600.5	
218 0J15792835 7912600.5	
512 WHEETERST 7417500.5	
500 0471265365 791	
20H.0495 39595 19. 12000.0	
248.0009470511 7312000.0	
246.0522213525 /91000.0	
252.0534350442 7912000.0	
258.0547687357 7912800.0	
264.8060424272 7912600.5	
270.0573161137 7912600.0	
276.0535898103 7912600.5	
202 0590635018 7912600.5	
299 0611371933 7912600.5	
294 0624102949 79, -12600.5	
500 0626945764 7912600.5	
300,0000040104 17, 1000010 300,000000079 73 -10400 5	
300.0049302019 19. T10000.0	
312.0062319094 7812441.	
318.06/000651 7812441.	
324.0637793425 7712281.5	
330.070053034 7411303.	
336.0713267256 6810846.	
342.0726004171 538453.5	
348.0738741086 223509.	
354, 0751478001 -49, 7815.5	
360.0764214917 -207, 33016, 5	
THECOL CONTROL CORD	
ILLUGAL CONTROL CARD.	

Completify constrained (See Note on west pose)

0. -317. -30561.5 6.001273691528 -317. 50561 12.00254738306 -316. 50402. 50561.5 18.00382107453 -207. 33016.5 24.00509476611 -49. 7815.5 30.00636845764 22. -3509. 36.00764214917 53. -8453.5 42.00091584069 68. -10846. 48.01018953222 74. -11803. 54.01146322375 77. -12281.5 60.01273691528 78. -12441. 66.0140106063 73. -12441. 72.01528429883 79. -12600.5 78.01655798986 79. -12600.5 84.01783168139 79. -12600.5 90.01910537292 79. -12600.5 96.02087906444 79. -12600.5 102.021652756 79. -12600.5 108.0229264475 79. -12600.5 114.024200139 79. -12600.5 120.0254738306 79. -12600.5 126.0267475221 79. -12600.5 132.0280212136 79. -12600.5 138.0292949051 79. -12600.5 144.0305685967 79. -12680.5 150.0318422882 79. -12600.5156.0331159797 79. -12600.5162.0343896712 79. -12600.5 168.0356633628 79. -12600.5 174.0369370543 79. -12600.5 180.0332107458 79. -12600.5 186.0394844374 79. -12600.5192.0407581289 79. -12600.5198.0420318204 79. -12600.5 204.0433055119 79. -12600.5 210.0445792035 79. -12600.5 216.045852895 79. -12600.5 222.0471265865 79. -12600.5 79. -12600.5 223.0484002781 79. -12600.5 234.0496739696 240.0503476611 79. -12600.5 246.0522213526 79. -12600.5 252.0554950442 79. -12600.5 79. -12600.5 258.0547687357 264.0560424272 79. -12600.5 270.0573161187 79. -12600.5 276.0585898103 79. -12600.5 202.0098635018 79. 280.0611371933 79. 294.0624108849 79. 12600.5 -12600.5 -12600.5 300.0636845764 78. -12441. 386.8649582679 78. -12441. 312.0662319594 77. -12281.5 318.067505651 74. -11203. 324.0687793425 68. -10846. 330.070053034 53. -8453.5 336.0713267256 22. -3509. 342.0726004171 -49. 7815.5 348.0738741036 -207. 33016.5 360.0751478001 -316. 30402. 360.0764214917 -317. 30561.5 LLLUNE CONTROL CARD. or tellind

Completely constrained
T put in final Temps as if
initial Temp was 0°

$$\therefore$$
 strasses should be matricely
 $\frac{100-T}{T} \times \sqrt{T}$
 $\Theta=0 \left[\frac{100-(-317)}{-317}\right] = 0.562 = 66572$
 $\Theta=130 \left[\frac{100-(-317)}{-317}\right] = 0.562 = 66572$

ORIGINAL PAGE IS OF POOR QUALITY

15 Block

Constrained complet. Ser N. L. Su Sa

0 -3.7. JODD1
00 220/91528 -317. 50561.0
0.0010.001 73.3306 -317. 50561.J
12.0020102150 -317. 50561.3
18.00382107430 317 56561.5
24.00303476611 517 50561.5
39. 00636845.64 -317. 5561 5
35 00764214917 -317. 00001.5
10 0000 584069 -317. Debut 100
42.000000000000000000000000000000000000
48.01010200000 317. 50561.5
54.01146344310 517 SUBEL 5
60.01273691529 -51 - 50521 5
FF. M140106068 -317. 00061.0
20 000000000000000000000000000000000000
12.01000000000 -317. 50561.J
13.010001 20129 -916. 50402.
84.01.00100100 1007. 33016.5%
90.01919537222 10 2019 5
06. 32837906444 -49. 1010.0
100 001632756 223000 -
100.0000000004475 50. : 0403.0
100.000.000139 6810046.
119.00-00010 7411803.
120.0204/30000
126.0267475224 11. 2441
132.0230212136 7010++1.
100 0202943051 7812441.
100.000.00007 7912600.0
144.0300000000 7912600.5
150.0318462002 79 -12688.5
156.0331139791 12 15:00.5
1-2.0343396712
1. T. M. MAR 33628 791.0000
100.00000000000000000000000000000000000
114. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4. 4
L.U. COCLUTION IN - COURT
1.0.0394344017 1.5
112, J. 17381237
103 04.0318204 791.000.3
5 1 a. (20055112 79, 1. Conthed
-04.04000000000 79, -12600.4
2.0.0440 2000 73 -12000.0
2.0.04000000000000000000000000000000000
202.0471265660 (2. 1511)
167500 ALL 20002731 78. TECHTI
10 0.01700646 78 2441.
240.000 71 510 74 11303.
200.0000010000 -10846.
202.00042004 14 20* 20-10-10
253. JUN 168. 44. 43. 404
Sour 1050424272 22, 10007
520 0573161187 -13, (01914)
210.00000000000000000000000000000000000
202.0093030010 17. 50561.0
283.06113(1232 - 355 - 36561.)
294.06241088+9 1011 - 505-1 -
200.0636343764 -317. 00001.2
Dat 0649582679 -317. 00001.
300.001 0594 -317. 50561.0
312.0000011001 -317. 58561.5
318.06/000601 0117 50561.5
324.0037793420 -311.00561 5
330.070053034 -317. 00001.0
226 07:3267256 -317. 00061.0
313 0226004171 -317. 50561.5
342.07.02741026 -317, 50561.5
348.0.001410000 -317, 50561.3
354.07014/0001 317 50561.5
368.0764214917 -317. 000011
SHEET NO. 57.91 SUBJECT. DATE CHIND. HW The pook stresses are tensile stresses and they are proportionial to the amount of and constraint on the cylinder. For the completely constrained cyli the encount of esperal surface does not affect the prate stress whereas for the other for cases only. This part of the turned is flexible in the axiel direction. Therefore the park tensile stores occusive ith only as mall exposed area and will have a maximum volve of 60,000 psie The comprosive stress increases with increasing exposed area, For helf of the shell exposed this stress is - 32,223 psi, weed to check this for buckling. From ref 1. 7 = Knort down farter Tx) cr= 1606 TEE L= <u>25</u> = 3.0 · R= 16.6612 = 182 E 16711 V= 128 TV) == (.606)(28)(29×106),67/96,66 = 34,107p) in for even half the shell exposed to has or GNL the compression stress is less them critical. ORIGINAL PAGE IS OF POOR QUALITY





FINTTE ELEMENT MODEL.

The closed form solution is not valid wear the ends and also assume that hoop strises are small compared to axial straiges. A right circular cyl. 25' long, was modeled to check these two points plus allow For complex accident simulation and complix structurel grometry (reinforcing ring). A completel constrained model was run with half the cyl. Lexposed to GN2 Flow, The results ;~ the contra of the cyl. (away From ands) agreed excellently: However much higher exicl (factor of 2) stroses and heap stroses existed wear the ends. Also, a is bending only middle was run, The strass the mille did not corre with (they were lower) and the war much higher Therefor, and couldions ere significant and the finile element medal should se used to product Fatigor life.

ORIGINAL PAGE IS OF POOR QUALITY

subject from a Present AND DATE SHEET.NO. CHILD BY DATE JOS NO. RESULTS OF SPAR FINITE ELEMENT THE I BLOCK CASE WAS RUN IN SPAR COMPLITER RUN NO. "EDQ" THE MAXIMUM BENDING STRESS AT JOINT 496 (CORNER LOCATION) 15 99,640 PSi THE DEMBRANE STRESS AT THIS LOCATION 15 54,860 PSI THE 3 BLOCK CASE IN SHOWN IN RUN DFZ. THE 15 BLOCK CASE WAS RUN IN SPAR COMPUTER RUN NO. ECK." MAXIMUM BENDING STRESS AT JOINT 496 15 127,110 PSi MEMBRANE STRESS 15 65,940 PSI

THE MODEL AND RESULTS ARE SHOWN IN THE FOLLOWING PAGES. THE MAX. STRESSES OCCUR AT THE FIXED BOUNDARY CONDITIONS.

> ORIGINAL PAGE IS OF POOR QUALITY

1 OF 17

1 BLOCK @ - 315°F COMPUTER RUN CBZ

)

1/1/1

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

-16

SCALE

C

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

-2

Q

1 1

NILLE 4, OUT THE		(1000	NODE=	4,	SURFACE=	0
------------------	--	-------	-------	----	----------	---

S)ISPLAY=

C

* }

C

~	/1000 .	NODE=
---	---------	-------

TOP HALF OF CYLINDER

PRECEDING PAGE BLANK NOT FILMED

ł		
	0	

	and the second	-	0 1	U 1	-						
	0	0								0	2
	0	C	o	o	0	O	0	0	0		
							0	0	0	o	2
0	D	0	0	0	D	0		-	-		
					0	o	0	0	0	0	2
0	0	0	0		1			+	+	1	
	1		0	0	0	0	0	0	0	0	2
0	0	0				+	+	+			2
	0	0	0	0	0	0	0	0	0		+
0			+	+	+	1	0	0	0	0	2
0	0	0	0	0	0				-+		1
		+_		0	0	0	0	0	0	0	
0	0	0					1	0	0	0	1
0	0	0	0	0	0	0					
-											

	1	P	E	C	
ĵ	1		1		
•	1		1		

.c.s.u ni ebom

2 OF 17

)

DISPLAY= SX /1000, NODE= 4, SURFACE= 1

1/1/1

Q 23 SCALE

1

1

0	0	0	0	0	0	0	0	0	0	٥	2	1	-22
0	D	O	0	o	O	O	D	O	D	O	2	1	-22
0 .	O	O	0	o	D	O	O	O	0	0	2	1	-22
C	C	0	0	0	0	0	0	0	0	O	2	1	-22
a	D	0	٥	O	O	0	O	0	0	O	2	1	-22
0	0	0	D	0	0	0	٥	0	O	O	2	1	-22
		0	0	0	D	0	0	0	0	0	2	1	-22
	-												
С	0	O	0	0	0	0	0	0	O	0	5	1	-55
0	C	0	O	o	D	o	O	o	D	o	2	1	-22
0	0	0	o	0	D	O	O	O	O	O	2	1	-22
0	0	0	0	0	0	0	0	0	0	0	2	1	-22
0	0	o	0	o	C	0	0	0	0	o	2	1	-22
0	C	0	0	0	O	O	o	0	o	o	2	1	-22
o	0	o	O	0	O	o	O	0	O	O	2	1	-22
0	0	0	0	0	0	0	0	0	D	0	2	1	-55

SPEC TOP HALF OF CYLINDER 4.1 THERMO LOADS

OLO BLODDIO MONTON CONTRACTOR STORES 1

3 OF 17

.)

-)

DISPLAY= SX /1000, NODE= 4, SURFACE= 2

1/1/1

с	٥	0	0	0	0	0	0	0	O	0	2	-5	-11
O	٥	D	D	0	D	٥	٥	D	D	0	2	-5	-11
O	D	O	D	O	0	O	٥	O	O	O	2	-5	-11
С	D	D	0	0	0	0	D	0	0	0	2	-5	-11
C	D	O	O	ο	O	D	D	0	D	0	2	-5	-11
o	O	o	O	ο	o	o	O	σ	o	O	2	-5	-11
o	D	٥	O	o	0	o	O	o	D	O	2	-5	-11
o	O	O	o	o	D	σ	O	o	o	σ	2	-5	-11
o	o	٥	O	o	o	D	o	o	D	o	2	-5	-11
0	D	O	o	o	D	D	O	o	D	o	2	-5	-11
0	0	0	o	o	O	O	O	O	o	o	2	-5	-11
O	o	o	O	o	D	o	D	o	O	o	2	-5	-11
0	o	o	O	O	0	O	O	o	O	o	2	-5	-11
O	O	O	O	O	O	O	O	D	0	O	2	-5	-11
0	D	0	0	0	O	O	0	O	D	0	5	-5	-11
				and the second se	Contraction of the local division of the loc	the second s	the second se	the second se					

SPEC 4.1

)

TOP HALF OF CYLINDER THERMO LOADS

.

Q 2. SCALE

.

1

1

-

OLC Graphic revources contraction purchas 200

1

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

1

0	0	D	0	0	0	O	0	O	D	O	2	-2	-16
0	0	0	0	0	O	O	O	O	0	O	2	-2	-16
0	O	O	0	0	0	0	0	0	0	0	2	-2	-16
0	0	D	0	O	0	o	0	C	D	O	2	-2	-16
C	D	o	o	O	o	σ	O	σ	a	O	2	-2	-16
D	O	0	O	0	O	O	0	С	D	0	2	-2	-16
σ	O	σ	a	σ	O	σ	O	C	C	σ	2	-2	-16
0	O	O	O	O	D	O	D	C	D	0	2	-2	-16
O	O	O	O	O	O	O	O	σ	O	O	1	-2	-15
0	D	0	O	0	D	O	C	0	D	0	1	-1	-12
С	O	O	O	o	O	O	0	O	O	O	0	O	-8
0	O	O	O	0	O	O	O	O	O	o	-1	2	3
σ	C	ο	O	ο	O	o	O	0	0	O	-3	3	26
0	0	0	O	0	0	O	0	0	D	0	-4	3	54

1

DISPLAY= SX /1000, NODE= 4, SURFACE= 0

0

0

0

0

0

0

)

1/1/1

-16

BLK 4 OF 17

-2

Q

1

11

SCALE

1 BLK 5 OF 17

)

-)

DISPLAY= SX /1000, NODE= 4, SURFACE= 1

. .

1	1	1	1	1
1	/	1	/	*

0	0	o	0	o	0	٥	D	D	O	٥	2	1	-22
O	O	O	0	σ	O	D	0	O	O	D	2	1	-22
0	0	0	O	O	o	o	O	o	O	O	2	1	-22
0	D	O	O	O	o	o	O	0	O	o	5	1	-22
0	O	O	O	O	D	o	D	D	D	D	2	1	-22
0	o	o	o	D	o	o	D	o	o	O	2	1	-22
0	D	o	o	o	o	o	o	o	o	٥	2	1	-22
1	1	1	1	1	O	σ	ŋ	ο	o	σ	2	1	-22
1	1	1	1	1	1	1	1	1	D	o	2	2	-21
1	1	1	1	1	1	1	1	1	1	O	2	2	-20
0	D	o	O	1	1	1	1	1	1	1	2	3	-18
0	O	O	O	o	O	o	1	1	1	1	1	5	-13
0	0	O	D	O	O	O	D	O	O	1	-2	8	O
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	0	-6	6	23
-1	-1	-1	-1	-1	-1	-1	-1	-2	-2	-1	-8	-4	65

1

SPEC 5.1 BOTTOM HALF OF CYLINDER THERMO LOADS

(C)4

Q SCALE

1

1

0 .00 hoto 6867-668(FIT) 010100 10000

IBLK 6 OF 17

)

DISPLAY= SX /1000, NODE= 4, SURFACE= 2

1/1/1

0	D	0	0	0	0	0	0	0	O	0	5	-5	-11
0	0	O	D	0	O	O	0	O	D	O	2	- 5	-11
0	O	O	O	0	D	0	D	O	O	0	2	-5	-11
0	0	0	0	0	D	0	0	0	0	٥	5	-5	-11
D	D	0	O	o	D	0	C	D	D	D	5	-5	-11
O	O	O	D	o	O	D	C	o	D	o	2	-5	-11
0	O	O	0	D	0	0	D	. 0	D	O	2	-5	-11
-1	-1	-1	-1	-1	-1	Ο	D	O	D	σ	2	-5	-10
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	D	1	-5	-10
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	-5	-9
0	D	O	0	-1	-1	-1	-1	-1	-1	-1	0	-6	-7
0	D	ο	0	٥	D	С	-1	-1	-1	-2	D	-6	-2
 D	O	C	D	O	D	ο	O	Ο	O	-1	O	-4	6
1	1	1	1	1	1	1	1	1	1	σ	1	1	24
1	1	1	1	1	1	1	1	2	2	2	1	10	43

1

Contraction of Contract of States

SPEC 5.1

BOTIOM HALF OF CYLINDER THERMO LOADS

1

Q 23 SCALE

1

OLC CLOSUIC MONICON CO

7 OF 17

1/1/1

)

-)

DISPLAY= SY /1000, NODE= 4, SURFACE= 0

-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
13		-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	.13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13			-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13			12	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13			+		+
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
									and the second sec	and the second se			

SPEC 4.1

TOP HALF OF CYLINDER HERMO LOADS

1

C

1

Q SCALE

1

1

8 OF 17

1/1/1

)

)

DISPLAY= SY /1000, NODE= 4, SURFACE= 1

-13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -13 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -32 -3 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -32 -3 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -32 -3 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 - . ? -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32 -13 -13 -13 -13 -13 -13 -13 -13 -13 -13 -14 -12 -3 -32

Contractor and the subsection of the

'PEC 4.1

-

TOP HALF OF CYLINDER THERMO LOADS SCALE 23

Q

.

1 BLK 9 OF 17

1

).

-)

DISPLAY= SY /1000, NODE= 4, SURFACE= 2

1/1/1.

-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6

SPEC 4.1

1

÷....

TOP HALF OF CYLINDER THERMO LOADS

1

OLO graphic resources corporation hundington beach, solitorial (714)333 2.32 Charlen of no. 1

1

1

1

SCALE

Q

10 OF 17

1/1/1 .

DISPLAY= SY /1000, NODE= 4, SURFACE= 0

.

33	33	33	33	33	33	33	33	33	33	33	33	33	34
8	8	8	8	8	8	8	8	8	8	8	ų	7	10
-3	-3	-3	-3	-3	-3	3	-4	-4	-4	-4	-4	-4	-2
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-8	-7
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-10
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
-13	-13	-13	-13	-13	-12	-12	-12	-12	-12	-12	-12	-12	-12
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-03
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13

)

)

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

.0.00 NI 422-

Q 23 SCALE

OF 17

1/1/:

DISPLAY= SY

)

NODE= 4, SURFACE= 1

-	1	IUUL	, ,

8	8	8	8	8	8	0						+	+
-	+-		+		-		8	8	7	9	5	-1	30
_4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-3	-5	-2	-1
-9	-9	-9	-9	-9	-9	-9	-9	-9	-8	-8	-8	-2	-17
-11	-11	-11	-11	-11	-11	-11	-11	-11	-10	-11	-10	-2	-26
-12	-12	-12	-12	-12	-12	-12	-12	-12	-11	-12	-11	-3	-29
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-12	-3	-31
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-12	-3	-31
-12	-12	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
.3	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32

SPEC 5.1

BOTTOM HALF OF CYLINDER THERMO LOADS

SCALE

ł

Q

and the state of the second second second

OLO Braphic resources corporation - hundington beach, collionita (708)303 128 - Charl no. 1

12 OF 17

)

DISPLAY= SY /1000, NODE= 4, SURFACE= 2

1

1/1/1

-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-22	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-22	6
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-11	-12	-21	6
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-19	5
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-15	3
-3	-3	-3	-3	-3	-3	-3	-3	-3	-4	-4	-3	-6	-3
8	8	8	8	8	8	8	8	8	8	7	10	16	-9
34	34	34	34	34	34	34	34	34	34	32	36	55	-7

1

SPEC 5.1

.1

BOTTOM HALF OF CYLINDER THERMO LOADS

1

Q 23 SCALE

C

1000 Ju 0100







IBLK 16 OF 17) 1/1/1 Q 35 SCALE ALL SPEC 7.1 c 3 ton hords sees see (XIA) planta hord not planta not see see a second of the second sees see a second of the second se l .c.a 1 0000 1 1 ١



-	68		125	-168-	-1#3	119	090	-12	312	313	378	199	196	-HEA
35	66	97	128	159	1:30	221	252	283	314	345	376	407	438	469
30	6/	138	129	160	131	1222	253	284	315	346	377	408	439	470
37	68	- 99	011	161	195	223	254	282	316	347	378	409	440	471
38	69	100	131	162	192	224	255	286	312	348	379	410	441	472
39	20	101	132	163	10	225	256	287	318	349	380	411	442	473
40	21	102	133	164	195	226	257	298	319	350	381	412	443	474
41	72	103	134	165	196	227	258	289	320	351	382	413	444	475
42	23	104	135	166	197	228	259	290	321	352	383	414	445	476
43	74	105	136	167	198	229	260	291	322	353	384	415	446	477
44	75	106	137	168	199	230	261	292	323	354	385	416	447	478
uς	20	1.02	1.20		200	231	260	1000	2011	000	-			
45	1/6	107	130	1.63	- CUU	Kai -	202	233	324	155	386	417	448	479
46	77	108	139	170	201	232	263	294	325	356	387	418	449	480
47	78	102	140	121	202	233	264	295	326	357	388	419	450	481
18	79	110	141	172	203	234	265	295	327	358	389	420	451	462
19	80	hu	142	173	204	235	266	297	328	359	390	421	452	483
50	81	112	143	1.24	205	236	267	298	329	360	391	422	453	484
51	82	113	144	175	206	237	268	299	330	361	392	423	454	485
52	83	114	145	1.76	207	238	269	300	331	362	793	424	455	196
із.	84	115	146	477	208	239	270	301	332	363	394	425	455	467
4	85	116	147	178	209	240	271	302	333	364	395	426	457	488
5	86	117	148	179	210	241	272	303	334	365	396	427	458	489
6	87	118	149	180	211	242	273	304	335	366	397	428	459	490
7	8.P	110	150	1.0.	212	243	2711	305	1226	200	200	luon	143	130
8	00	1.20	1.50	1.00	Dia	Sun	0.55	1200	230	1007	13.38	929	460	491
9	30	121	152	183	214	245	276	307	338	369	199	430	461	492
9	91	133	153	184	815	346	837	308	339	320	HAL	H32	H63	433
-	and the second			100			and the second						Partia	1490

ORIGINAL PAGE IS OF POOR QUALITY

SPEC

J BLK CASE RUN "DFZ"

7.84

11		99	150	152	169	118		280	312					
35	66	97	128	159	190	221	-	083	1211		1273	-	+	
36	67	98	129	160	191	222	253	284	315	346	322	107	438	
37	68	99	130	161	192	PDA	054	290	1210	10117		100	- 433	-470
R	69	100	1.21	1.00		-		100	-110	- 141	378	409	440	471
				-162	193	224	255	286	317	348	379	410	441	472
39	20	101	132	163	194	225	256	287	318	349	380	411	442	479
luo	0.	1.00	1.00											-113
10		- HUR	133	164	195	226	257	588	319	350	381	412	443	474
41	72	103	134	165	196	227	258	283	0SE	351	382	413	huun	1125
													-111	-415
42	23	104	135	166	197	228	259	290	321	352	383	414	445	476
43	- 74	105	136	167	198	553	260	291	322	353	384	415	446	477
													1	
44	75	106	137	168	199	230	261	292	323	354	385	415	huna	1120
					1								127	-4.18
45	76	107	138	169	200	291	200	000	-					
			1	1.02	100	Test.	- COC	631	1324	1322	386	417	448	479
46	22	100	100	1.0	-	1								
	11	100	1.33	110	201	535	263	294	325	356	387	418	449	480
47	78	109	140	171	202	233	264	295	326	1757	388	1110	LEC.	
									1	1 mil	100	-113	400	481
48	29	110	141	1172	203	2211	ant	-						
		1	1	1	rua_	234	205	296	327	358	389	420	451	182
49	80	1	1.00						1					
14	au	+	1142	173	204	235	266	297	328	359	390	421	452	483
		1												
50	81	112	143	174	205	236	267	298	1329	036	391	1000	4000	
								1	Tana	1	T	120	903	-484
51	82	113	144	175	205	277	DER	200	220	500				
				1.12	1.00	1-1-	200	233	UEEL.	1301	1392	423	454	485
52	83	1114	145	176	207	000	000						1	
		1	1 10	1.00	CHI.	E30	263	300	331	365	393	424	455	486
Εđ	84	115	146	1.22	200	000			1					
		1	1 10	111	ena	233	270	301	332	363	394	425	456	487
54	85	116	147	178	Pne	2110	6	200					1.5	
			1	1.10		290	FIL.	1305	333	364	395	426	457	488
5	86	117	148	179	210	241	272	303	334	365	395	1122	1.50	
6	87	118	149	180	211	200	0.01		and al 1	100	2.20	Pic/	428	469
-	00			100		242	273	304	335	366	397	428	459	490
	88	119	150	181	212	243	274	305	336	367	398	429	450	491
8	89	120	151	182	213	244	275	306	332	368	399	430	UCI	1101
0	91	122	152	163	214	245	276	307	338	369	400	431	462	198
-	198	11.52	154	102	218	518 ····	516	108	209	320	HDL	432	463	LIGU

SHELL

SPEC 3.1

.

3 BLX 2 OF 21

9<u>30</u> SCALE

32	. 63		125	156	187	218		280	311	342	2/3	404	435	- 400
33	64	35	126	157	188	219	250	281	312	343	374	405	436	467
34	65	36	127	150	189	220	251	282	313	344	375	406	437	466
35	66	37	128	159	190	221	252	283	314	345	376	407	438	469
36	67	98	129	160	191	222	263	284	315	346	377	408	439	470
37	68	- 99	1 30	161	192	223	264	285	316	347	378	409	440	471
38	69	100	131	162	193	224	255	286	317	348	379	410	441	472
39	20	101	132	163	194	225	256	267	318	349	380	411	442	479
ча		102	193	164	1.95	226	257	288	319	350	381	412	443	474
41	72	103	134	165	196	227	258	283	320	351	382	413	444	475
42	73	104	135	166	197	228	259	290	321	352	383	414	445	476
43	74	105	136	167	198	229	260	291	322	353	384	415	446	477
44	75	106	137	168	199	230	261	292	323	354	385	416	447	478
45	26	107	138	169	200	231	262	293	324	355	386	417	448	479
46		108	139	170	201	232	263	294	325	356	387	418	443	480
47	28	hoa	140	171	202	233	264	235	326	357	388	413	450	481

TOP HALF OF CYLINDER THERMO LOADS SPEC 4.1

Q 23 SCALE

ww

BLK

2

.

Ur	ORI	
5	GIN	
0	A	
	PAG	
	LIT	1

6

							000	096	326	357	388	419	450	481
7	78	109	140	171	202	233		[T					
8	29	110	141	172	503	234	265	296	327	358	389	420	461	1902
9	80		142	179	204	235	266	297	326	359	390	421	452	483
-		110	143	1.24	205	236	267	298	329	360	391	422	453	484
50	HI	- HIC		1.25	205	237	268	299	330	361	392	423	454	485
51	82	113	199	175	Eva					260	393	424	455	486
62	83	114	145	176	202	238	269	300	1331	JOC				
53	84	115	146	177	208	239	270	301	332	363	394	425	456	487
C 11	85	116	147	178	203	240	271	302	339	364	395	426	457	466
			148	129	210	241	272	303	394	365	396	427	458	_489
55	86							2011	295	366	397	428	459	490
56	87	118	149	180	211	242	273	309						
57	88	119	150	181	212	243	274	305	336	367	398	429	460	491
	69	120	151	182	213	244	275	306	337	368	399	430	461	492
hq		1.01	152	183	214	245	276	307	338	369	400	431	462_	493
59	90								209	370	401	432	463	494
60	91	122	153	184	215	246	277_	308						
61	32	123	154	185	216	247	278	309	340	371	402	433	464	495
62	93	124	155	186	212	248	279	310	341	372	403	434	465	496

3 BLK 4 OF 21

SPEC 5.1

BOTTOM HALF OF CYLINDER THERMO LOADS

23 Q SCALE

1 E

. 167



ORIGINAL PAGE IS OF POOR QUALITY

DISPLAY= SY /1000 . NODE= 4. SURFACE= 0

				-	-			_					
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13 '	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-12
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-10
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-8	-7
-3	-3	-3	-3	-3	-3	-4	-4	-4	-4	-4	-4	-4	-5
6	3	8	ß	B	8	8	8	6	B	8	ß	8	10

٠.

SPEC 4.1 TOP HALF OF CYLINDER THERMO LOADS

O SCALE 23

0. W

10

2

BLK

1/1/1

.

DISPLAY= SX /1000 . NODE= 4. SURFACE= 1

.

										Lange and the second		Carlo In and	
D	O	D	0	D	0	0	0	-1	0	٥	-8	1	64
O	D	D	-1	-1	-1	-1	-1	-1	-1	O	-10	-4	83
-1	-1	-1	-1	-1	- 1	-1	-1	-1	-1	O	-10	-5	87
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	O	-9	-5	88
-1	-1	-1	-1	-1	-1	-1	-1	-1	o	1	-8	-4	89
-1	-1	-1	- 1	-1	-1	-1	O	-1	O	1	-7	-4	83
O	٥	D	o	o	O	O	o	o	o	1	-7	-4	89
Ο	0	D	0	O	0	D	D	O	D	1	-7	-4	69
0	0	0	٥	0	0	D	O	٥	1	1	-7	-4	89
D	D	D	0	O	O	O	O	D	O	1	-7	-4	83
O	D	D	0	O	O	D	O	Ο	D	1	-7	-4	85
D	O	O	O	D	D	O	٥	O	O	1	-7	-4	89
D	D	U	D	D	D	D	D	D	D	1	-7	-4	89
O	D	D	D	O	D	D	0	D	O	1	-7	-4	83
D	٥	0	0	C	0	O	0	D	O	1	-7	-4	89

SPEC

BOTION HALF OF CYLINDER.

BLK OF 21

Q 23 SCALE

.

JW

1/1/1

*

٩. -

DISPLAY= SX /1000, NODE= 4, SURFACE= 2

1/1/1

0	0	O	0	0	0	0	0	O	1	O	-1	8	45
o	0	1	1	1	1	1	1	1	5	1	-2	16	49
1	1	1	1	1	1	1	1	1	2	1	-4	20	45
1	1	1	1	1	1	1	1	1	5	0	-5	20	43
1	1	1	1	1	1	1	1	1	1	o	-6	20	43
1	1	1	1	1	1	1	٥	D	1	-1	-6	20	43
٥	o	o	٥	O	O	D	٥	٥	1	-1	-6	20	43
o	o	σ	O	ο	O	O	o	o	1	-1	-6	20	43
o	o	o	0	0	0	0	0	o	1	-1	-6	20	43
o	o	ο	D	Ο	O	O	D	O	1	-1	-6	20	43
O	O	o	O	0	O	D	0	O	1	-1	-6	20	43
o	o	o	٥	o	o	o	o	O	1	-1	-6	20	43
O	O	O	D	D	D	O	D	D	1	-1	-6	20	43
D	D	σ	O	O	0	0	D	D	1	-1	-6	20	43
D	ο	O	0	o	O	0	D	o	1	-1	-6	20	43

. .

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

Q 23 SCALE

. .

00 W BLK OF 21

1.182



DISPLAY= SY /1000, NODE= 4, SURFACE= 0

33	33	33	33	33	33	33	33	33	33	33	33	34	35
61	51	61	61	61	61	61	51	61	61	61	61	62	61
51	51	51	51	51	51	51	51	51	51	51	51	51	51
51	51	61	51	51	51	51	51	61	51	51	61	61	61
51	Б1	61	51	Б١	61	61	61	Б1	61	51	61	Б١	61
51	51	51	51	51	51	51	61	51	61	51	51	51	61
Б1	51	51	51	61	61	61	51	61	51	61	51	51	61
61	51	51	51	51	51	51	61	51	51	61	61	61	51
51	Б1 ,	51	51	61	61	61	61	Б1	51	Б1	51	61	Б1
61	61	61	.51	٤١	61	51	٤١	51	61	61	61	61	61
Б1	Б1	61	61	51	61	51	61	Б١	51	61	51	Б١	61
51	61	51	61	61	61	61	61	51	51	51	61	51	61
61	61	61	61	61	61	61	£1	£1	61	61	61	61	61
51	51	51	51	51	51	51	51	51	51	51	51	51	51
61	61	61	61	61	61	61	61	61	61	61	61	61	61

۰.

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

Q 23 SCALE

T BLK

1/1/1

.

DISPLAY= SY /1000 . NODE= 4. SURFACE= 1

1/1/1

-

181

2 6

BLK OF 21

F		and the second se					the second s		and the second se	and the second se	and the second state of th		
33	33	33	33	33	33	33	33	33	33	35	31	12	78
61	Б1	61	51	61	61	61	E 1	Εı	61	64	49	18	114
51	51	51	51	51	51	51	51	Б1	51	64	49	13	123
51	Б1	51	61	51	Б1	Б١	61	61	61	64	49	11	127
51	61	51	61	61	Б1	Б١	61	61	61	65	60	11	128
51	51	51	51	51	51	61	61	61	61	62	60	12	128
51	51	Б1	51	61	61	61	51	61	61	65	60	12	127
51	B 1	51	51	51	61	51	61	5۱	61	66	60	12	127
БІ	Б1	Б1	Б1	Б1	Б1	Б١	Б1	БІ	61	66	60	12	127
61	61	Б1	61	61	61	6۱	61	5۱	61	66	60	12	127
бі	Б1	51	51	Б١	61	Бι	61	5۱	61	65	50	12	127
Б1	61	51	51	51	61	51	61	Б١	61	65	60	12	127
61	51	61	61	61	£1	£1	<u>6</u> 1	61	61	ee	60	12	127
51	51	51	51	51	51	51	51	51	51	65	50	12	127
61	61	61	61	61	61	e1	61	61	61	EE	60	12	127

.

~

ORIGINAL PAGE IS OF POOR QUALITY

SPEC

BOTTOM HALF OF CYLINDER

SCALE 23 Q

DISPLAY= SY /1000 . NODE= 4. SURFACE= 2

	the second se	the state of the second st	the state of the second st	Contraction of the State of the	the second se	a construction of the second second	the second second second second second						
33	33	33	33	33	34	34	34	34	34	31	35	66	-8
61	61	Б1	61	61	61	5۱	61	65	62	49	63	86	-11
65	65	<u>65</u>	52	52	52	52	52	65	52	48	53	90	-22
es	65	65	65	25	65	52	65	65	65	48	53	91	-25
65	65	<u>65</u>	65	65	62	25	61	65	65	48	53	91	-26
52	62	<u>65</u>	61	51	61	51	51	62	52	48	53	ອເ	-25
61	Б1	61	61	61	61	Б1	61	65	65	48	63	91	-26
ចរ	61	61	61	51	51	51	£1	62	62	48	63	91	-24
Б١	Б1 _/	61	Б1	Б1	Б1	61	Б1	52	65	48	63	91	-25
61	61	Б1	61	51	61	Б١	61	65	62	48	63	91	-25
61	61	51	61	61	61	51	61	65	62	48	63	91	-25
51	61	51	61	61	61	5۱	61	65	65	48	63	91	-26
٤١	51	61	61	61	61	61	61	es	<u>e</u> 5	48	63	91	-56
51	51	51	51	61	51	٤١	51	52	52	48	53	31	-25 .
61	61	61	61	61	61	61	61	es	es	48	63	91	-56

SPEC 5.1

BOTTOM HALF OF CYLINDER THERMO LOADS

Q 23 SCALE

1/1/1

1

NW

01

2

BLK




DISPLAY= SX /1000, NODE= 4, SURFACE= 2

* *

0 0 0 2 -6 -11 ٥ 0 0 0 0 0 0 0 0 0 0 2 -6 -11 0 0 0 D D 0 0 0 0 0 0 0 0 O D 0 2 -5 -11 0 D 0 0 S -5 -11 D D 0 0 0 0 0 0 0 0 2 -6 -11 0 0 0 0 0 0 0 0 0 0 0 0 S -5 -11 0 D 0 0 0 0 O D D 0 0 0 0 0 0 0 2 -6 -11 ٥ 0 0 0 0 D 0 0 2 -5 -11 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 5 -5 -10 -1 -1 0 -10 -1 0 0 1 -5 -1 -1 -1 -1 -1 -1 -1 -1 -9 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 -1 1 -5 -7 -1 -1 -1 -1 -1 -1 -1 -1 0 -6 -1 -1 -1 -2 -1 -2 D -6 -1 -1 -1 -1 -1 -1 -1 -1 -1 -4 б 0 0 0 0 0 -1 -1 -1 -1 -1 -2 -1 24 0 0 0 0 0 0 0 0 0 0 -1 -1 0

x x

SPEC 4.1 TOP HALF OF CYLINDER THERMO LOADS Q 23 SCALE

1/1/1 . .

W G BLK

N

.

DISPLAY= SY /1000, NODE= 4, SURFACE= 1

1/1/1

		description and a state											
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-35
-13	-13	-13	-13	-13	-13	-13	-13	-13	-19	-14	-12	-3	-35
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-35
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-12	-12	-12	-12	-12	-12	-12	-13	-12	-12	-14	-12	-3	-32
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-12	-3	-31
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-11	-3	-29
-11	-11	-11	-11	-11	-11	-11	-11	-11	-10	-11	-10	-2	-26
-9	-9	-9	-9	-8	-8	-8	-8	-8	-8	-8	-8	-2	18
-3	-3	-3	-3	-3	-3	-Ξ	£-	-3	-3	-3	-4	-2	-1
8	8	8	8	8	8	8	8	8	ß	9	6	O	30

TOP HALF OF CYLINDER THERMO LOADS SPEC 4.1

9 Q_____SCALE

16 BLK DE 2 12

DISPLAY= SX /1000 . NODE= 47 SURFACE= 1

٥	0	O	Ο	O	D	٥	Ο	٥	٥	O	.2	1	-55
D	0	D	O	D	0	D	Ο	0	D	D	2	1	-22
O	D	a	D	ο	Ο	D	D	σ	D	σ	2	1	-22
0	O	0	D	0	0	Ο	0	o	D	O	5	1	-55
o	o	O	o	O	O	٥	o	٥	٥	o	2	1	-22
o	D	ο	D	٥	O	D	o	σ	D	σ	2	1	-25
o	o	o	o	o	o	o	٥	o	٥	o	5	1	-22
o	o	σ	o	ο	D	ο	o	D	D	O	2	1	-22
ı	D	o	0	o	O	٥	o	o	٥	٥	2	1	-22
1	1	1	1	1	1	1	1	1	o	o	2	_1	-21
۱	1	1	1	1	1	1	1	1	1	O	2	2	-20
ı	1	1	1	1	1	1	1	1	1	1	2	з	-18
۱	1	1	• 1	1	1	1	1	1	1	s	1	e	-13
D	o	o	D	D	o	1	1	1	1	s	-2	8	D
o	o	o	D	o	O	O	O	D	1	1	-6	7	59

SPEC 4.1

TOP HALF OF CYLINDER THERMO LOADS

Q_____23

5 W 82K 50

10

NET.

1/1/1

DISPLAY= SX /1000, NODE= 74, SURFACE= 0

٥	ο	D	0	Ο	0	D	D	٥	Ο	O	-5	ч	64
٥	0	D	0	D	0	D	0	D	1	Ο	-6	6	66
D	D	ο	D	D	O	D	D	D	1	D	-7	8	66
o	o	O	O	D	O	O	O	O	1	ο	-7	8	66
o	o	D	o	ο	o	O	٥	D	1	o	-7	8	66
o	D	ο	o	σ	v	D	D	σ	1	σ	-7	8	66
٥	٥	٥	٥	c	O	٥	٥	٥	1	o	-7	8	66
o	o	ο	0	σ	D	σ	O	σ	1	σ	-7	8	66
o	o	ο	O	O	D	٥	o	o	1	C	-7	8	66
o	o	σ	D	o	o	o	D	σ	1	σ	-7	8	66
o	O	o	O	σ	o	ο	o	σ	1	o	-7	8	66
D	o	D	o	ο	D	O	O	o	1	C	-7	8	66
D	o	σ	D	σ	D	D	D	σ	1	σ	-7	8	66
o	D	σ	D	σ	D	σ	D	σ	1	D	-7	8	66
o	o	o	O	D	0	D	D	o	1	0	-7	8	66

. .

e 4

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

0 23 SCALE

. .

2 w

BLK

2

1/1/1

ORIGINAL PAGE IS OF POOR QUALITY

.

DISPLAY=

SX

		A STATISTICS	the second have				and shall be						
0	o	O	Ο	ο	0	O	O	-1	O	٥	-8	1	64
٥	O	D	-1	-1	-1	-1	-1	-1	-1	D	-10	-4	83
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	σ	-10	-5	87
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	O	-9	-5	88
-1	-1	-1	-1	-1	-1	-1	-1	-1	D	1	-8	-4	89
-1	-1	-1	-1	-1	-1	-1	D	-1	O	1	-7	-4	89
٥	o	٥	o	٥	0	٥	0	٥	o	1	-7	-4	89
o	o	σ	D	O	O	o	O	o	D	1	-7	-4	89
٥	o	o	o	٥	o	٥	0	٥	1	1	-7	-4	89
o	o	o	o	o	o	o	o	O	o	1	-7	-4	89
D	o	o	o	D	o	o	O	o	O	1	-7	-4	89
D	o	D	o	D	o	o	o	D	o	1	-7	-4	89
D	D	D	D	D	٥	D	D	D	D	1	-7	-4	89
٥	D	D	o	D	D	o	D	D	D	1	-7	-4	89
٥	o	o	O	o	O	o	D	0	D	1	-7	-4	89

/1000, NODE= 7. SURFACE=

19 01=

9

23

SCALE

Q_

...

W

BLK

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS 1/1/1

1

.

.

1/1/1

DISPLAY= SX /1000 . NODE= 4. SURFACE= 0

											1		2	-16	
	٥	0	٥	0	o	0	٥	0	٥	0	0	5	-2	-10	
	0	0	D	0	σ	D	O	C	σ	Ο	O	2	-2	-16	
	0	D	D	D	O	D	D	O	σ	0	σ	2	-2	-16	
F		0	G	0	0	0	0	0	0	0	o	s	-5	-16	
				0	0	0	0	0	0	0	o	2	-2	-16	
-						0	0	0	0	0	o	5	-2	-16	1
	0	0												-16	1
	٥	0	a	Ó	0	0	٥	٥	0	0	0	2			-
ł	0	0	0	0	D	D	0	0	0	0	σ	2	-2	-16	_
-		0	0	0	0	0	0	0	0	0	o	2	-2	-16	
		+			+	0	0	0	0	0	0	2	-2	-16	
	0	0	0				+				+	+		-15	-
	0	0	0	0	0	0	0	0	0	0	0	<u> </u>			
	0	0	0	0	0	0	0	O	0	o	0	ı	-1	-12	
	0	0	0	0	U	0	D	0	D	O	U	D	D	-8	
	-			0	0	0	0	0	0	0	D	-1	2	3	
	0					0	0	0	0	0	0	-3	ч	27	,
	0	0	0					1							

TOP HALF OF CYLINDER THERMO LOADS 3 PLK

14

SCALE 23

Q

111

SPEC 4.1 DISPLAY= SY /1000, NODE= 4 SURFACE= 2

and the second se			and the second se			and the second se							and the second se
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-53	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-53	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-53	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-53	б
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-22	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-55	6
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-11	-12	-21	6
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-19	Б
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-15	З
-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-3	-5	-2
8	8	8	8	8	8	в	8	8	8	7	9	16	-9

OF POOR QUALITY

SPEC 4.1 TOP HALF OF CYLINDER THERMO LOADS

Q 23 SCALE

2 W BLK OF 21

.

*

.

15 BLK - RUN 'ECK" 1 0= 19

Q

SCALE

33	68	95	126	159_	183_	218	290	280	312_	343-	378	404	.430	-1988
35	66	97	128	159	190	221	252	283	314	345	376	407	438	469
36	67	98	129	160	19:	222	253	294	315	346	377	408	439	470
37	68	99	130	161	192	223	254	285	316	347_	378	409	440	471
38	69	100	131	162	193	224	255	286	317	348	379	410	441	472
39	70	101	132	163	194	225	256	287	318	349	380	411	442	473
40	71	102	133	164	195	226	257	288	319	350	381	412	943	474
41	72	103	134	165	196	227	258	289	320	351	382	413	444	475
42	73	104	135	166	197	228	259	290	321	352	383	414	445	476
43	74	105	136	167	198	229	260	291	322	353	384	415	446	477
44	75	106	137	168	199	230	261	292	323	354_	385	416	447	478
45	76	107	138	169	200	231	262	293	324	355	386	417	448	479
46	77	108	139	170	201	232	263	294	325	356	387	418	449	483
47_	78	109	140	171	202	233	264	295	326	357	388	419	450	491
48	79	110	141	172	203	234	265	296	327	358	389	420	451	482
49	80	111	142	173	204	235	266	297	328	359	390	421	452	483
50	81	112	143	174	205	236	267	298	329	360	391	422	453	-484
51	82	113	144	175	206	237	268	299	330	361	392	423	454	_485
52	83	114	145	176	207	238	269	300	331	362	393	424	455	-486
53	84_	115	146	177	208	239	270	301	332	363	394	425	456	487
54	85	116	147	178	209	240	271	302	333	364	395	426	457	488
55	86	117	148	179	210	241	272	303	334	365	396	427	458	489
56	87	118	149	180	211	242	273	304	335	366	397	428	459	490
57	88	119	150	181	212	243	274	305	336	367	398	429	160	491
50	99	120	151	182	213	244	275	306	337	368	399	430	461	_1492
59	90	121	152	183	214	245	276	307	338	369	400	43:	1962	493
60	- 91	188	183		-1215	-12:19	1270	13:5	310	1312	1103	1137	1104	=1499

SHELL AND RING ALL

ORIGINAL PAGE IS OF POOR QUALITY

.

)



13	.03	.25	.120	192	1112	.511	1 . eig		,313	312	1374	.488-	434 _	402
19	66	97	128	153	ΊČ	221	The c	293	314	1315_	315	407	438	469
16	67	98	129	160	191	222	253	284	315	346	377	408	439	470
37	68	99	130	161	192	223	254_	285	316	347	378	409	440	471
38	69	100	131	162	193	224	255	286	317	348	379	410	441	472
39	70	101	132	163	194	225	256	287	318	343	380	411	442	473
40	71	102	133	164	195	226	257	288	319	350	381	412	443	474
41	72	103	134	165	196	227	258	289	320	351	382	413	444	475
42	73	104	135	166	197	228	259	290	321	352	383	414	445	476
10	211	1.05	136	167	198	229	260	291	322	353	384	415	446	477
43	1/4	- HUS	130	+	1.20	-								
44	75	106	137	168	199	230	261	292	323	354	385	416	447	478
45	76	107	138	169	200	231	262	293	324	355	386	417	448	479
	22	109	139	170	201	232	263	294	325	356	387	418	449	480
46		100	100	10	101	LVL	T	1						
47	78	109	140	171	202	233	264	295	326	357	388	419	450	481
48	79	110	141	172	203	234	265	296	327	358	389	420	451	482
49	80	111	142	173	204	235	266	297	328	359	390	421	452	483
50	0.1	112	143	174	205	236	267	298	329	360	391	422	453	484
50	-	-			T									
51	82	113	144	175	206	237	268	299	330	361	392	423	454	_485
52	83	114	145	176	207	238	269	300	331	362	393	424	455	486
53	84	115	146	177	208	239	270	301	332	363	394	425	456	487
54	85	116	147	178	209	240	271	302	333	364	395	426	457	488
	00	117	148	179	210	241	272	303	334	365	396	427	458	489
55	00		1110	190	211	242	273	304	335	366	397	428	459	490
56	87	118	119	101	210	0112	271	305	336	367	398	429	460	491
57	88	119	150	101	010	000	075	200	237	359	399	430	461	492
58	89	120	152	182	213	245	275	307	338	369	400	431	462	493
60	91	122	1153	1184	215	246	222	308	339	1330	1481	433	163	-49

SPEC 3.1 SHELL

15 BLK 3 OF 18

SCALE 30

Q

32	63		125	156	187	218	249	280	311	342	373	404	435	466
33	64	95	126	157	188	219	250	281	312	343	374	405	436	467
34	65	96	127	158	189	220	251	282	313	344	375	406	437	468
35	66	97	128	159	190	221	252	283	314	345	376	407	438	469
36	67	98	129	160	191	222	253	284	315	346	377	408	439	470
37	68	99	130	161	192	223	254	285	316	347	378	409	440	471
38	69	100	131	162	193	224	255	286	317	348	379	410	441	472
39	70	101	132	163	194	225	256	287	318	349	380	411	442	473
40	71	102	133	164	195	226	257	288	319	350	381	412	443	474
41	72	103	134	165	196	227	258	289	320	351	382	413	444	475
42	73	104	135	166	197	228	259	290	321	352	383	414	445	476
43	74	105	136	167	198	229	260	291	322	353	384	415	446	_477
44	75	106	137	168	199	230	261	292	323	354	385	416	447	478
45	76	107	138	169	200	231	262	293	324	355	386	417	448	479
46	27	108	139	170	201	232	263	294	325	356	387	418	449	480
47 _	78	1109	140	171	202	233	264	295	326_	357	388	419	450	481

- SPEC TOP

TOP HALF OF CYLINDER , .

Q_____23

15 BLX 4 OF 18

ň 15 BLK

147	78	109	140	171	202	233	264	295_	326	357	388	419	450	481
48	79	110	141	172	203	234	265	296	327	359	389	420	451	482
49	80		142	173	204	235	266	297	328	359	390	421	452	483
50	81	112	143	174	205	236	267	298	329	360	391	422	453	484
51	82		144	175	206	237	268	299	330	361	392	423	454	485
52	- 93	114	145	176	207	238	269		331	362	393	424	455	486
53	84	115	146	177	208	239	270		332	363	394	425	456	487
54	85	116	147	178	209	240	271	302	333		395	426	457	488
55	86	117	148	179	210	241	272	303	334	365	396	427	458	489
56	87	118	149	180	211	242	273	304	335	366	397	428	459	490
57	88	119	150	181	212	243	274	305	336		398	423	460	491
58	89	120	151	182	213	244	275	306	337	368	399	430	461	492
59	90	121	152	183	214	245	276	307	338	369	400	431	462	493
60	91	122	153	184	215	246	277	308	339	370	401	432	463	494
61	92	123	154	185	216	247	278	309	340	371	402	433	464	495
62	93	124	155	186	217	248	279	310	341	372	403	434	465	496

1

-....

- . ..

4

ORIGINAL PAGE IS OF, POOR QUALITY

-

DISPIR/= S7 /1000, MODEL 4, SURFALL 0

BOTTOM HALF OF CYLINDER THERMO LOADS

									T	T	1		
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-13
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-12
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-10
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-8	-8	-8	-7
-4	-4	-4	-4	-4	-4	-4	-4	-3	-3	-3	-4	-4	-2
8	8	8	8	8	8	8	8	8	8	8	8	8	11
33	33	33	33	33	33	33	33	33	33	33	33	34	35
51	51	51	51	51	51	51	51	51	51	51	51	52	51
52	52	51	51	51	51	51	51	51	51	51	51	51	51

RUN D DFZ 182

· ?= 10

SPEC 5.1

14

30

Q 23 SCALE

(.

1/1/

S DISPLAY= S7 /1000, NODE: 1 . SURFACE: 1

	BOT	TOM H	HALF	OF C	YLINE	DER							Ç SC	ALE 23	3	1	017
51	51	51	5	1 51	51	5	5	1 50	50	5	4 43		5 1.	_		0	(
51	51	51	51	51	51	51	51	50	50	54	49		3 124	-		L	
33	33	33	33	33	33	33	33	33	33	35	31	12	18	+			
8	8	8	8	8	8	8	8	8	8	9	6	0	30	+			
-4	-3	-3	-3	-3	-3	-3	-3	-3	-3	-3	-4	-2	-1	+			
-9	-9	-9	-9	-8	-8	-8	-8	-8	-8	-8	-8	-2	-18				
-11	-11	-11	-11	-11	-11	-11	-11	-11	-10	-11	-10	-2	-26				
-12	-12	-12	-12	-12	-12	-12	-12.	-12	-12	-12	-11	-3	-29				
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-13	-12	-3	-31				
-12	-12	-12	-12	-12	-12	-10	-13	-12	-13	-14	-12	-3	-32				
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32				
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32				
13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-13	-3	-32				
13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32				
13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32				

BOTTOM HALF OF CYLINDER THERMO LOADS

SPEC 5.1

· · ·

1/1/1 -

1

no

BEK 18

DISPLAY= SY /1000, NODE= 4, SURFACE= 2

								Survey 15 States 1					
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-22	6
-12	-12	-12	-12	-12	-12	-12	-12	-12	-12	-11	-12	-21	6
-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-11	-19	5
-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-9	-15	3
-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4	-3	-5	-2
8	8	8	8	8	8	8	в	8	8	7	10	16	-9
34	34	34	34	34	34	34	34	34	34	31	35	56	-8
51	51	51	51	51	51	51	51	52	52	49	53	85	-12
52	52	52	52	52	52	52	52	52	52	48	53	90	-22

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

Q 23 SCALE 6 1

OF POOR QUALITY

DISPLAY= SY /1000 . NODE: - I. SURFACE. 0

1/1/1

				a contract of the most of		and the second second			and the second se				
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-13
And in case of the second second second	and the second second second second	and the second second second	and the second sec	And and a second second second second second	and the second s	and the second sec							

TOP HALF OF CYLINDER THERMO LOADS SPEC 4.1

0 23 SCALE

15 BLK 9 of 18

.

-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32
-13 -13	-13	-13	-13	-13	-13	-13	-13	-13	-14	-12	-3	-32

SPEC 4.1

TOP HALF OF CYLINDER THERMO LOADS

0 23 SCALE

E .

15 BLK

1/1/1

DISPLAY= SY /1000, NODE: 4, SURFACE. 2

						· · · · · · · · · · · · · · · · · · ·	sugar that down on many a	Contract and send or constraints		Company of the second second			
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	1 - 2 5	6
-13	-13	-13	-13	-13	-13	-13	-13	-13	-13	-12	-13	-23	6

SPEC TOP HALF OF CYLINDER 4.1 THERMO LOADS Q 23 SCALE

15 BLK

1/1/

1/1/1

DISPLAY= SX /1000, NODE= 4, SURFACE= 1

O	٥	0	D	0	0	0	0	0	۵	O	2	1	-22
o	0	D	0	D	0	O	D	٥	0	0	2	1	-22
o	٥	D	0	0	D	σ	O	Ο	O	σ	2	1	-22
o	0	O	D	0	O	0	0	0	0	0	2	1	-22
o	0	o	D	٥	O	O	D	O	٥	٥	2	1	-22
o	o	σ	o	σ	O	o	σ	o	O	ο	2	1	-22
o	O	0	D	0	0	0	O	O	0	o	2	1	-22
D	o	o	O	0	O	0	O	O	O	O	2	1	-22
o	O	0	D	o	D	o	o	0	O	o	2	1	-22
o	σ	o	0	O	0	σ	O	σ	O	σ	2	1	-22
o	o	0	0	O	٥	0	D	o	O	0	2	1	-22
o	0	C	C	O	0	0	0	o	0	o	2	1	-22
O	0	0	0	0	0	O	0	D	O	σ	2	1	-22
0	0	o	o	O	0	0	0	O	0	O	5	1	-22
0	0	0	0	0	0	0	0	0	0	0	5	1	-55

SPEC . 4.1

IOP HALF OF CYLINDER

Q 23

15 BLK

OF POOR QUALITY

1

0	D	D	0	O	0	0	0	С	٥	0	2	-2	-18
o	D	0	O	٥	0	O	0	٥	0	٥	2	-2	-16
o	O	ο	0	ο	D	D	٥	D	0	O	2	-2	-16
0	0	٥	0	O	O	0	D	O	0	0	2	-2	-15
o	D	O	D	٥	0	ο	0	٥	0	O	2	-2	-16
O	0	o	o	σ	0	ο	O	O	O	σ	2	-2	-16
o	0	o	o	o	O	o	o	D	D	o	2	-2	-16
o	O	o	o	o	O	o	o	ο	D	ο	2	-2	-16
0	o	o	o	o	o	o	0	D	D	o	2	-2	-16
σ	o	σ	σ	σ	a	ο	O	o	U	O	2	-2	-16
0	o	o	O	o	o	0	O	o	0	0	5	-2	-16
0	0	0	o	o	O	0	D	O	D	O	2	-2	-16
o	o	o	0	ο	o	o	0	O	O	o	2	-5	-16
0	0	0	0	o	a	0	0	0	0	0	2	-2	-16
0	0	0	D	0	0	0	0	0	0	0	2	-2	-16

DISPLAY= SX /1000, NODE= 4, SURFACE= 0

*

1/1

SPEC

W 5 BLK OF 18

.

1/1/1

DISPLAY= SX /1000, NODE= 4. SURFACE= 1

	and the second second second					A CALL AND A				a second and a second sec	President (President President		
0	0	0	0	٥	C	0	D	0	0	0	2	1	-22
O	O	۵	0	0	O	٥	0	٥	0	C	2	1	-22
O	0	O	0	O	O	O	0	D	0	Ο	2	1	-22
O	0	o	0	0	0	0	0	O	O	0	2	1	-22
o	0	D	D	٥	O	ο	O	D	0	O	2	1	-22
1	1	1	O	σ	0	σ	O	σ	O	σ	2	1	-22
1	1	1	1	1	1	1	1	1	O	o	2	1	-21
1	1	1	1	1	1	1	1	1	1	0	2	2	-20
1	1	1	1	1	1	1	1	1	1	1	2	3	-18
1	1	1	1	1	1	1	1	1	1	2	1	5	-13
o	O	o	o	O	1	1	1	1	1	2	-2	8	٥
o	O	o	o	o	0	O	D	O	1	1	-5	7	29
-1	-1	-1	-1	-1	-1	-1	-1	-1	0	O	-8	1	64
-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	U	-10	-4	83
-1	-1	-1	-2	-2	-2	-2	-2	-2	-2	-1	-10	-5	87

SPEC BOTTOM HALF OF CYLINDER 5.1 THERMO LOADS

r. . .

0 23 SCALE

1/1/1

15 BLK 8

DISPLAY= SX /1000, NODE- ', SURFACE 2

		1			and the second									
	0	D	0	0	0	0	0	0	0	0	0	5	-5	-11
. 0	D	0	0	O	o	0	0	O	D	0	0	2	-5	-11
	O	0	σ	O	O	0	0	O	D	0	o	2	-5	-11
	O	0	o	O	D	O	0	0	o	0	0	5	-5	-11
	o	0	O	o	D	o	0	O	o	o	o	2	-5	-11
	-1	-1	-1	o	σ	O	o	o	o	O	σ	2	-5	-10
	-1	-1	-1	-1	-1	-1	-1	-1	o	-1	o	1	-5	-10
	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	1	-5	-9
	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	o	-6	-7
	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-2	o	-6	-2
	D	0	0	O	-1	-1	-1	-1	-1	-1	-2	-1	-4	6
	0	0	D	0	0	D	O	0	0	O	-1	-1	D	25
	1	1	1	1	1	1	1	1	1	1	O	-1	8	45
-	1	1	1	1	1	1	1	1	1	2	1	-2	16	49
L	1	1	2	2	2	2	2	2	2	3	1	-3	20	44

SPEC 5.1 BOTTOM HALF OF CYLINDER THERMO LOADS

Q 23 SCALE 23 ON LA SCALE 3

.....







. FATTLUE DAMAGE FROM LN2 OF GAZ AT OTPE LOCATIONS IN TUNNEL TIPICAL STRUCT RING 1. Striss Velus LAS ACCEVENT THERMAL STARSF 9 Pressure Transient accide accide VH 17 65 TL 25 - 16:0 60, 2-2.2 31. 2-32. operating cycle - NORMAL edte P Htupt End 23.5 17 10.5 0 TH = 05=41 9 25 41 0 5. consting citle with accident during sis. 23.5 17 10.5 0 U7 => 125= 85 62.0 85. 41 2 51 operation, aque with accident beginning Trows ed 10.5 0 23.5 17 54 DS = 46.5 ٩ 0 -7 5. - 23 ORIGINAL PAGE IS OF POOR QUALITY i smill accident yield higher stresses * An and strong do not add, to ht up, cycle because

. SA= 1 (85)(3) = 127.5 => N= 300 cyclo 2 from Asme m Asme This is stress level during accident and the fetigue damage from this accident must be colded to the fatigue damage from wormal operation to determine how it affects shill life. Lif of vossil for morris operation (1) = 31 years Damag . factor for wormal operation = 3 Ni $20\left(\frac{1}{2}\right) = L \quad or \quad 3N_{1} = 20$ $N_{1} = L$: 2 Ni = 20 = ,645 No = # of accident, Total faligue d'amage ≤1 in 20 yours R Ni + No =1 Na Linie or L= 20 1 31 29 10 2 Ni No 50 25 21 100 .0973 Ma DL:

. . . . The state SHEET NO. OF DATE CHKD. BY DATE JOB NO. 2. ELLIPTICAL AING-WELD

Stress Jalves LN2 Accident VII I 22.22 6.5 -1 smill hage T. I 20.63 -10.0 60. 2-2.8 31. 2-320 worst stresses will accive during small accident on cd+D P Ht+P End TH 28,77 22,22 15.72 0 DS= 80.63 T- 164.13 20.63 36.63 O Ch= 1 (80.63)(3)= 121 => N=300 For wormal operation h= 15 years Na L 15 1 => from linear regression And. 10 15 50 14 01 = .03 Na 100 12

100309

ORIGINAL PAGE IS OF POOR QUALITY NASA - CR - 115301 ENGINEERING HANDROOK Page 1 of 10 FOR THERMOSTRUCTURAL ANALYSIS OF PLATES & SHELLS.

TSN 5.3.0-1

THERMAL BUCKLING OF ISOTROPIC CIRCULAR CYLINDRICAL SHELLS; EITHER EDGE CLAMPED OR SIMPLY SUPPORTED

NOTATION

المنظر والمحد المحد والمناحة المحالية والمحالية المحالية المحالية

REF:

Α .	= Area of cross section taken normal to the axis of revolution, in^2 .
E	= Young's modulus, psi.
^I y' ^I z	= Area moments of inertia taken about the y and z axes, respectively, in ⁴ .
L	= Overall length of the cylinder, in.
M _x	= Running bending moment about middle surface of shell wall (see Figure 2), $\frac{\text{in-lb}}{\text{in}}$.
$\overline{M}_y, \overline{M}_z$	= Overall bending moments about the y and z axes, respectively
	(see Figure 2), in-lb.
$(\overline{M}_y)_A$, $(\overline{M}_z)_A$	= Artificial values for \overline{M}_y and \overline{M}_z , respectively [see Equations (7)].
	in-lb.
$(\overline{M}_y)_B; (\overline{M}_z)_A$	= Artificial values for \overline{M}_y and \overline{M}_z , respectively [see Equations (9)].
	in-lb.
P	= Axial force (see Figure 1), lb.
\overline{P}_A	= Artificial value for \overline{P} [see Equations (6)], 1b.
P _B	= Artificial value for \overline{P} [see Equations (9)], 1b.
R	= Radius of cylinder middle surface, in.
T	= Temperature change from that of an initial unstressed state or
	reference temperature (positive for a temperature rise), "F.
t · · ·	= Thickness of shell wall, in.
w	= Radial deflection of shell wall, in.
x, y, z	= Rectangular Cartesian coordinates (see Figure 1), in.
α	= Coefficient of linear thermal expansion, $\frac{\ln}{(\ln)(F)}$.
ORIGINAL PAG OF POOR QUAL	E IS ITV

-411 4. -----

TSN 5.3.0-1 Page 2 of 10 NOTATION . = Knock-down factor (see Figure 3), dimensionless. Y V = Poisson's ratio, dimensionless. = Artificial axial stress defined by Equation (5), psi. σA = Axial stresses due to the artificial bending moments $(\overline{M}_y)_B$ and $\left({}^{\sigma}\overline{M}_{y}\right)_{B}$, $\left({}^{\sigma}\overline{M}_{z}\right)_{B}$ $(\bar{M}_z)_B$, respectively, psi. $\left(\sigma \overline{p} \right)_{B}$ = Axial stress due to the artificial force \overline{P}_{B} , psi. = Axial stress, psi. ox. (ox)Max = Peak value for σ_x , psi. (ox)cr = Critical axial stress for buckling of the cylinder, psi. = Angular coordinate (see Figure 1), radians.

Note: All stresses are positive in tension.

TSN 5.3.0-1 Page 3 of 10

(1)

(2)

CONFIGURATION

The design curves and equations provided here apply only to thin-walled, right circular cylinders which satisfy the relationship

$$L/R \ge \frac{3.2}{\left(\frac{R}{t}\right)^{1/2}}$$

and are made of isotropic material. It is assumed that the shell wall is free of holes, obeys Hooke's law, and that it is of constant thickness. Figure 1 depicts the isotropic cylindrical shell configuration. Figure 2 shows the sign convention for forces, moments, and pressures.

BOUNDARY CONDITIONS

The following types of boundary conditions are covered:

a. Simply supported edge; that is,

$$w = M_{\perp} = 0$$
 at $x = 0$ and/or $x = L$

$$w = \frac{\partial w}{\partial x} = 0 \quad \text{at } x = 0 \text{ and/or } x = L \tag{3}$$

It is not required that the conditions at the two ends be the same. In every case, it is assumed that the cylinder (including any end rings) is not subjected to external axial constraints at any location around the boundaries at x = 0 and x = L.

TEMPERATURE DISTRIBUTION

The supposition is made that no thermal gradients exist through the wall thickness and in the axial direction. However, arbitrary circumferential variations may be present. The permissible distributions can therefore be expressed in the form .

 $T = T(\phi)$

(4)



Hoop membrane compression may develop in regions adjacent to the two ends due to external radial constraint. However, the buckling mode associated with this condition is not considered. Because of this and the lack of external axial constraints, the special case of a uniform temperature is of no interest here.

DESIGN CURVES AND EQUATIONS

It is assumed that Young's modulus and Poisson's ratio are unaffected by temperature changes. Hence, in using the contents of this TSN, the user must select effective values for each of these properties by applying engineering judgement. It will sometimes be desirable to employ different effective moduli in each of the following operations:

a. Computation of the stresses σ_x present in the cylinder.

b. Computation of the critical buckling stress $(\sigma_x)_{cr}$.

On the other hand, the results are presented in a form which enables the user to fully account for temperature-dependence of the thermal-expansion coefficient α .

The appropriate formulation for σ_x can be obtained by first imposing a fictitious stress distribution σ_A around the boundaries at x = 0 and x = L such that all axial thermal deformations are entirely suppressed. It follows that

 $\sigma_{A}=-\alpha \tilde{\mathrm{ET}}(\phi)$

These stresses may be integrated around the circumference and through the wall thickness to arrive at the force

zin '

ORIGINAL PAGE IS OF POOR QUALITY

$$\overline{P}_{A} = -EtR \int_{0}^{2\pi} \alpha T(\phi) d\phi$$

and the moments

$$\left(\overline{M}_{y}\right)_{A} = -ER^{2}t \int_{0}^{2\pi} \alpha T(\phi) \sin \phi d\phi$$

(6)

(7)

(5)

ATSN 5.3.0-1 Page 6 of 10

$$\left(\overline{M}_{2}\right)_{A} = -ER^{2}t \int_{0}^{2\pi} \alpha T(\phi) \cos \phi \, d\phi$$

Since it is assumed that the shell is free of external axial constraints, the conditions

$$\overline{\mathbf{P}} = \overline{\mathbf{M}}_{\mathbf{y}} = \overline{\mathbf{M}}_{\mathbf{z}} = 0 \tag{8}$$

must be satisfied at x = 0 and x = L. To restore the shell to such a state, it is necessary to superimpose a force \overline{P}_B equal and opposite to \overline{P}_A as well as moments $(\overline{M}_y)_B$ and $(\overline{M}_z)_B$ which are equal and opposite to $(\overline{M}_y)_A$ and $(\overline{M}_z)_A$, respectively. Hence,

$$\overline{\mathbf{P}}_{\mathbf{B}} = -\overline{\mathbf{P}}_{\mathbf{A}}$$

$$\left(\overline{\mathbf{M}}_{\mathbf{y}}\right)_{\mathbf{B}} = -\left(\overline{\mathbf{M}}_{\mathbf{y}}\right)_{\mathbf{A}}$$

$$\left(\overline{\mathbf{M}}_{\mathbf{z}}\right)_{\mathbf{B}} = -\left(\overline{\mathbf{M}}_{\mathbf{z}}\right)_{\mathbf{A}}$$

The stress corresponding to $\overline{\mathbf{P}}_{\mathbf{B}}$ is easily found to be

$$\left(\sigma_{\overline{P}} \right)_{B} = \frac{\overline{P}_{B}}{A} = \frac{\overline{P}_{B}}{2\pi Rt} = \frac{E}{2\pi} \int_{0}^{2\pi} \alpha T(\phi) d\phi$$
 (10)

The stresses due to $(\overline{M}_y)_B$ are

$$\left({}^{\sigma}\overline{M}_{y} \right)_{B} = \frac{ \left(\overline{M}_{y} \right)_{B} z}{{}^{t}y} = \frac{ \left(\overline{M}_{y} \right)_{B} z}{\pi \kappa^{3} t} = \frac{E \sin \phi}{\pi} \int_{0}^{2\pi} \alpha T(\phi) \sin \phi \, d\phi$$
 (11)

And those due to $(\overline{M}_z)_{\rm R}$ are

$$\left({}^{\sigma}\overline{M}_{z} \right)_{B} = \frac{\left(\overline{M}_{z} \right)_{B} y}{I_{z}} = \frac{\left(\overline{M}_{z} \right)_{B} y}{\pi R^{3} t} = \frac{E \cos \phi}{\pi} \int_{0}^{2\pi} \alpha T(\phi) \cos \phi d\phi$$
(12)

The procedure being used constitutes an application of Saint-Venant's principle. Hence, the stresses from Equations (10) through (12) will be accurate representations only at sufficient distances from the ends x=0 and x=L. If end rings are present,

262

(7) (Contd)

(9)

TSN 5.3.0-1 Page 7 of 10

(14)

263

the greater their resistance to out-of-plane bending, the shorter will be this distance. Subject to these conditions, the actual longitudinal thermal stresses at various points in the shell may be computed from the relationship

$$\sigma_{\mathbf{x}} = \sigma_{\mathbf{A}} + \left(\sigma_{\mathbf{P}}\right)_{\mathbf{B}} + \left(\sigma_{\mathbf{M}_{\mathbf{y}}}\right)_{\mathbf{B}} + \left(\sigma_{\mathbf{M}_{\mathbf{z}}}\right)_{\mathbf{B}}$$
(13)

$$\sigma_{\mathbf{x}} = -\alpha \mathbf{E} \mathbf{T}(\phi) + \frac{\mathbf{E}}{2\pi} \int_{0}^{2\pi} \alpha \mathbf{T}(\phi) d\phi + \frac{\mathbf{E} \sin \phi}{\pi} \int_{0}^{2\pi} \alpha \mathbf{T}(\phi) \sin \phi d\phi$$
$$+ \frac{\mathbf{E} \cos \phi}{\pi} \int_{0}^{2\pi} \alpha \mathbf{T}(\phi) \cos \phi d\phi$$

Complex distributions may be encountered which make it difficult to perform the required integrations. In such instances, use can be made of numerical techniques whereby the integral signs are replaced by summation symbols.

To investigate the stability of a particular shell, the maximum longitudinal stress $(\sigma_x)_{Max}$ must be compared against the critical value which can be obtained from the formula

$$(\sigma_{\mathbf{x}})_{\mathbf{cr}} = \gamma \frac{\mathbf{Et}}{\mathbf{R}\sqrt{3(1-\nu^2)}}$$
(15)

For the design to be satisfactory, it is required that

00

$$(\sigma_x)_{Max} < (\sigma_x)_{cr}$$
 (16)

The quantity γ appearing above is a so-called kneck-down factor which mainly accounts for the detrimental effects from initial imperfections. Note that Equation (15) is identical to that used for uniformly compressed circular, cylindrical shells. Its application to the present problem is justified on the basis of small-deflection studies reported in References 1 and 2. From the results given in these references, it can be concluded that, regardless of the nature of the circumferential stress distribution, classical

ORIGINAL PAGE IS OF POOR QUALITY

or

TSN 5.3.0-1 Page 8 of 10

theoretical instability is reached when the peak axial compressive stress satisfies the expression

$$(\sigma_x)_{Max} \approx \frac{Et}{R\sqrt{3(1-\nu^2)}}$$

In view of this, the values used here for γ were determined from the 99% probability (confidence = 0.95) data for uniformly compressed cylinders as reported in Reference 3. The resulting γ values are plotted in Figure 2 for $\frac{L}{R}$ ratios of 0.25, 1.0, and 4.0.

(17)

(18)

(19)

264

SUMMARY OF EQUATIONS AND CURVES

$$\sigma_{\mathbf{x}} = -\alpha \mathbf{E} \mathbf{T}(\phi) + \frac{\mathbf{E}}{2\pi} \int_{\mathbf{0}}^{2\pi} \alpha \mathbf{T}(\phi) d\phi + \frac{\mathbf{E} \sin \phi}{\pi} \int_{\mathbf{0}}^{2\pi} \alpha \mathbf{T}(\phi) \sin \phi d\phi$$

+
$$\frac{E\cos\phi}{\pi} \int_{0}^{2\pi} \alpha T(\phi)\cos\phi d\phi$$

$$(\sigma_x)_{cr} = \gamma \frac{Et}{R\sqrt{3(1-\nu^2)}}$$

When $\nu = 0.3$ this gives

$$(\sigma_{\rm x})_{\rm cr} = 0.606 \ \gamma \frac{\rm Et}{\rm R}^{-1}$$
 (20)

The knock-down factor γ is obtained from Figure 3.


1.0

Y 0.1

0.01

102



· ...

103

R

10

ORIGINAL PAGE IS OF POOR QUALITY

265

7/2/26 Estimated Thermal Stresses in Deep "T" Then, will be some 19" high "T" ring ; in the LNa injection error of turnel. Need to Factor there into Fatigue energiss. Temperature Distribution Both the insulation thickness and the T'ring dight will be increased to 15". Therefore the resistance of the composite insulation will be increased approximately by a factor of the The deep "T' rings providented by in a higher speed log of the telen. I therefore the film cole f. will be the telen. I therefore the film cole f. will be the fotal resistance and row be real facted. Therefore the owned has been row be reduce S a feeting of 4, and it would be requerially hessense that the temp prod. in the deep T' (Telery - Tshill) will be the some a the Hert loss three I QOT. = KA (TEL., -Tohn) QDT = CST/ toT = 4 tST $(T_{f}-T_{s})_{oT} = Q_{sT} + \frac{4t_{sT}}{K_{A}} = (T_{f}-T_{s})_{sT} = 10 F^{2}$

ORIGINAL PAGE IS OF POOR QUALITY

Thermal Stross Use the results for the completely restrained. DT = 10' For Twoide - 3000 * 5.4 the shell promiting in the LN2 regions is Similies to 500 that for whigh curves curre outside 3000 2000 generated and will be good I enough for estimated

* JE = KEAT = (10 x10" (30 x10") (10 "F) UI = 3000 psi

ORIGINAL PAGE IS OF POOR QUALITY