



Consumers
Power
Company

James W Cook
Vice President - Projects, Engineering
and Construction

General Offices: 1945 West Parnall Road, Jackson, MI 49201 • (517) 788-0453

81-01 #1

February 13, 1981

Mr J G Keppler, Regional Director
US Nuclear Regulatory Commission
Region III
799 Roosevelt Road
Glen Ellyn, IL 60137



MIDLAND PROJECT -
DOCKET NOS 50-329, 50-330
UNDERRATED TERMINAL STRIPS ON LIMITORQUE VALVE OPERATORS
FILE: 0.4.9.47 UFI: 73*10*01, 40*10 SERIAL: 11190

This letter confirms the 50.55(e) item concerning the terminal strip voltage ratings on Limitorque valve operators. This was reported by telephone call to R Sutphin and R Knop of USNRC Region III, Glen Ellyn, IL, on January 14, 1981.

Enclosure 1 provides a description of the condition and the planned corrective action.

Another report, either interim or final, will be sent on or before April 24, 1981.

James W. Cook

WRB/lr

Enclosure: (1) MCAR-46, Interim Report #1 (February 5, 1981) - Underrated Terminal Strips on Limitorque Valve Operators

CC: Director of Office of Inspection & Enforcement
Att Mr Victor Stello, USNRC (15)

Director, Office of Management
Information & Program Control, USNRC (1)

RCook, USNRC Resident Inspector
Midland Nuclear Plant (1)

8102100 623

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CC: CBechhoefer, ASLB Panle
GALinenberger, ASLB Panel
FPCowan, ASLB Panel
AS&L Appeal Panel
MMCherry, Esq
MSinclair
CRStephens, USNRC
WDPaton, Esq, USNRC
FJKelly, Esq, Attorney General
SHFreeman, Esq, Asst Attorney General
GTTaylor, Esq, Asst Attorney General
WHMarshall
GJMerritt, Esq, TNK&J
Great Lakes QA Managers

Bechtel Associates Professional Corporation

021509

SUBJECT: MCAR 46 (issued 1/15/81)
Underrated Terminal Strips on
Limitorque Valve Operators

INTERIM REPORT 1

DATE: February 5, 1981

PROJECT: Consumers Power Company
Midland Plant Units 1 and 2
Bechtel Job 7220

Introduction

Description of Deficiency

In the process of ordering a replacement for a cracked terminal block, Bechtel determined that some terminal blocks in Limitorque valve operators may have been underrated for their intended function. The manufacturer's name is the only identification on the terminal blocks; thus, they were measured and compared with terminal blocks listed in Marathon Catalog 10M79. This comparison led to the suspicion that the terminal blocks used for the termination of the leads from the valve operator 460-volt motor were rated less than 460 V.

Eighteen Limitorque operators on Bechtel P.O. 7220-M-132-AC were inspected and eight had underrated terminal blocks. The subject P.O. is with Henry Pratt Company for the supply of nuclear service butterfly valves.

Potential Safety Implications

Seven of the eight valve operators having underrated terminal blocks are located in the component cooling water and service water systems and are used on safety-related valves. These must function on an emergency core cooling actuation signal. The potential exists for a short circuit/flashover which could render the valves inoperative.

Investigation

Investigation by Bechtel revealed that 8 of the 18 Limitorque operators have Marathon Series 100, Cinch Jones Series 140, or Beau Products terminal blocks having similar dimensions which are underrated for 460 V service. The other 10 operators inspected had Marathon Series 300 blocks which were initially rated by Marathon for 600-Volt service and have subsequently been derated to 300 volts by Marathon in their catalog 10M79. Representatives from Limitorque (J. Arnold) and Henry Pratt (B. Cummins) visited the Midland jobsite on January 13, 1981; after inspecting the terminal blocks, they confirmed the results of Bechtel's investigation.

Bechtel Associates Professional Corporation

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MCAR 46

Interim Report 1

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Limatorque, in its letter of January 21, 1981, (Attachment 1), has explained the circumstances which led to this derating of the Marathon Series 300 terminal blocks. Limatorque's states that the Marathon 300 Series terminal blocks are suitable for 600-volt service based on a manufacturer's test for 600-volt service (using a line-to-line breakdown voltage of 9,000 volts and a line-to-ground breakdown voltage of 11,200 volts.) Bechtel is further investigating Limatorque's statement.

In Attachment 2, Limatorque states that they do not stock Marathon 100 series terminal blocks. However, Limatorque believes that when their field service engineer visited the Midland jobsite in November 1977 to modify the terminal blocks in 66 operators (on the Henry Pratt order), he may have procured the subject terminal blocks locally. The Limatorque letter further explains that an additional 20 terminal blocks (140 series) manufactured by Cinch Jones were shipped to Midland. These blocks are equivalent to Marathon Series 100 blocks and may have been used to terminate the 460-volt motor leads by the Limatorque service engineer. The source of terminal blocks manufactured by Beau Products has not been determined. Seventy-one operators have been purchased on P.O. 7220-M-132-AC.

Corrective Action

1. Check all operators on P. O. 7220-M-132-AC and replace underrated terminal blocks.
2. Contact all suppliers of the Limatorque operators for all valve orders by February 16, 1981. Advise suppliers of the identified problem and request an evaluation of the correct rating of their terminal blocks. All suppliers will be reminded of their 10 CFR 21 commitment responsibility.
3. Develop a limited inspection program for other orders. If underrated blocks are then found, check all Limatorque operators for underrated terminal blocks and replace all underrated terminal blocks.

Reportability

Based on the potential safety concerns, this item was considered reportable. This deficiency was reported by Consumers Power Company on January 14, 1981, to R. Sutfin, R. Cook, and R. Knop of the Office of Inspection and Enforcement, Region III, U.S. Nuclear Regulatory Commission, as a reportable deficiency for Midland Plant Units 1 and 2 in accordance with 10 CFR 50.55e.

Bechtel Associates Professional Corporation

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MCAR 46
Interim Report 1
Page 3

Forecast Data for Investigation and corrective Action

The next interim report is scheduled for April 10, 1981.

- Attachments: 1. Letter, Limitorque to Henry Pratt, 1/21/81
2. Letter, Limitorque to Henry Pratt, 1/21/81

Submitted by:

W. Anderson

Approved by:

E. S. Lewis
FOR L. H. CURTIS

Concurrence by:

K. Wiedner

LIMITORQUE CORPORATION

5114 Woodall Road • P. O. Box 11318 • Lynchburg, Virginia 24506

Telephone—804-528-4400 • Telex—82-9448

021509



ATTACH-1

January 21, 1981

Henry Pratt Company
401 South Highland Avenue
Aurora, IL 60507

Attention: Mr. K. Wilson

Gentlemen:

Subject: Marathon 300 Terminal Strips

Limitorque has successfully used the Marathon 300 series terminal blocks for 600 volt service for over 10 years. These terminal strips were originally rated for 600 volt service based upon the breakdown voltage. Attached is a copy of a Marathon catalog cut dated July 15, 1974, which shows the Marathon 300 series rated at 600 volts.

Approximately 2 years ago, Marathon completed an Underwriter's Laboratory approval on the Marathon 300 series terminal strips. The Underwriter's Laboratory approval specified that the terminal strip was to be rated based upon dimensional requirements and not on breakdown voltage. The 300 series terminal block dimensionally meets the Underwriter's Laboratory specifications for a 300 volt rating. Enclosed is a copy from a 1979 Marathon catalog which shows that presently this terminal strip carries a UL rating of 300 volts.

We have also attached an article from the April 7, 1977, issue of Machine Design that explains the differences in rating methods. Please note this article states that most manufacturers rate terminal strips at 1/3 of the breakdown voltage. A copy of a Marathon terminal strip rating sheet is attached which shows the actual breakdown voltage for the 300 series block. The line to line breakdown voltage is 9,000 volts and the line to ground breakdown voltage

Mr. K. Wilson
January 21, 1981

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is 11,200 volts. These actual breakdown voltages are at least 15 times the 600 volt rating used by Marathon prior to the UL approval.

It is Limitorque's position based upon past experience and the actual breakdown voltages that the Marathon 300 series terminal strip is suitable for 600 volt service.

Please contact me if we can be of further assistance.

Very truly yours,

LIMITORQUE CORPORATION

Daniel S. Warsing

Daniel S. Warsing
Technical Manager

jhb

Attachments

cc: F. K. Denham
P. G. McQuillan
Vajay Shah/Bechtel Power Corp.

MEDIUM DUTY TERMINAL BLOCKS

PRICE LIST

100, 200, 300 AND 400 SERIES - STANDARD SCREW TERMINAL

021509



MEDIUM DUTY
TERMINAL BLOCKS

SECTION: 9110
PAGE: 3
DATE: JULY 15, 1974

SUPERSEDES
SECTION: 9210
PAGE: 7 & 8
DATE: JANUARY 3, 1974

No. Of Term.	SERIES 100 - 15A, 150V			SERIES 200 - 20A, 300V			SERIES 300 - 30A, 600V			SERIES 400 - 55A, 600V		
	Part No.	Lbs. C pcs.	* List Each	Part No.	Lbs. C pcs.	* List Each	Part No.	Lbs. C pcs.	* List Each	Part No.	Lbs. C pcs.	* List Each
1	0101081	1	\$.40	0201081	4	\$.44	0301081	6	\$.46	0401081	5	\$1.02
2	0102081	2	.48	0202081	4	.52	0302081	7	.65	0402081	11	1.42
3	0103081	2	.61	0203081	5	.64	0303081	9	.82	0403081	16	2.00
4	0104081	3	.78	0204081	7	.84	0304081	11	1.01	0404081	21	2.35
5	0105081	3	.93	0205081	8	.99	0305081	13	1.22	0405081	26	3.10
6	0106081	4	1.13	0206081	9	1.15	0306081	15	1.40	0406081	32	3.72
7	0107081	4	1.25	0207081	10	1.30	0307081	17	1.61	0407081	37	3.30
8	0108081	4	1.41	0208081	11	1.49	0308081	20	1.81	0408081	42	4.86
9	0109081	5	1.58	0209081	13	1.65	0309081	22	2.15	0409081	48	5.45
10	0110081	5	1.73	0210081	14	1.83	0310081	25	2.24	0410081	53	6.03
11	0111081	6	1.81	0211081	15	1.90	0311081	26	2.38	0411081	58	6.50
12	0112081	6	1.94	0212081	16	2.08	0312081	29	2.57	0412081	64	7.07
13	0113081	6	2.12	0213081	17	2.23	0313081	31	2.76			
14	0114081	7	2.26	0214081	18	2.40	0314081	33	2.97			
15	0115081	7	2.45	0215081	20	2.53	0315081	35	3.13			
16	0116081	8	2.61	0216081	21	2.72	0316081	38	3.37			
17	0117081	8	2.72	0217081	22	2.93	0317081	40	3.56			
18	0118081	9	2.92	0218081	23	3.02	0318081	42	3.75			
19	0119081	9	3.02	0219081	24	3.23	0319081	44	4.01			
20	0120081	10	3.17	0220081	25	3.39	0320081	46	4.20			
21	0121081	10	3.37	0221081	26	3.54	0321081	49	4.40			
22	0122081	11	3.56	0222081	27	3.75	0322081	51	4.57			
23	0123081	12	3.64	0223081	28	4.00	0323081	53	4.77			
24	0124081	12	3.74	0224081	29	4.09	0324081	55	4.96			
25	0125081	12	3.97	0225081	30	4.32						
26	0126081	13	4.19	0226081	32	4.58						
27	0127081	13	4.35	0227081	33	4.83						
28	0128081	14	4.49	0228081	34	5.02						
29	0129081	14	4.70	0229081	35	5.21						
30	0130081	15	4.89	0230081	36	5.42						
31	0131081	15	4.93									
32	0132081	15	5.08									
33	0133081	15	5.13									
34	0134081	16	5.42									
35	0135081	16	5.58									
36	0136081	16	5.73									

STANDARD SCREWS ARE NICKEL-PLATED STEEL, BINDER HEAD STYLE, CLASS 2 THREADS. BRASS BINDER HEAD SCREWS ARE AVAILABLE ON REQUEST. SUBSTITUTE 001 FOR 081 IN THE LAST THREE DIGITS ON THE PART NO. **FOR 100 AND 200 SERIES, ADD \$.02 PER LINE TO THE LIST PRICE ABOVE. FOR 300 AND 400 SERIES, ADD \$.04 PER LINE TO THE LIST PRICES ABOVE.

LIST PRICES SUBJECT TO STANDARD DISCOUNTS.

PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

POOR ORIGINAL

MARATHON
special products
Bowling Green, Ohio 43402
Telephone: (419) 352-8441

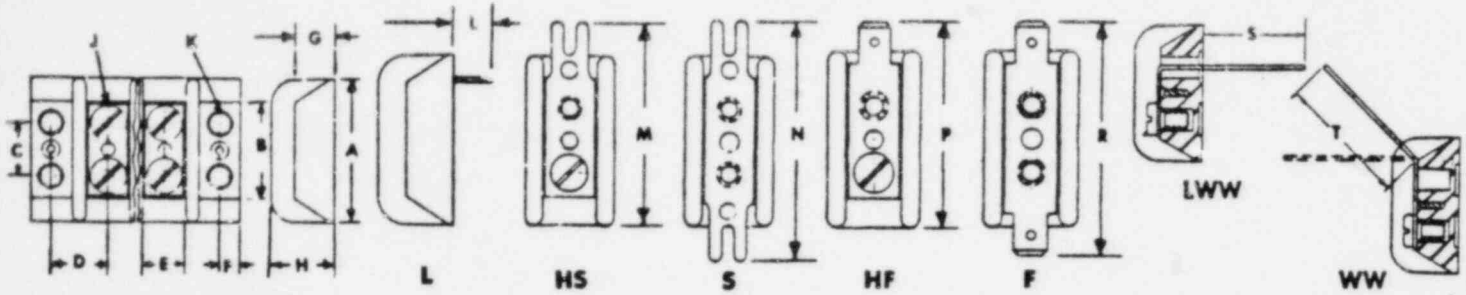
* CHANGED OR ADDED SINCE LAST ISSUE.

Controllead

MEDIUM DUTY--100-200-300-400 SERIES



021509



Series Number	Max Term	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T
100	36	3/8	3/8	3/8	3/8	1/4	3/8	3/32	3/16	5-40 x 1/4	.160	3/16	1 3/4	1 1/2	..	..	..	..
6A100	36	3/8	3/8	3/8	3/8	1/4	3/8	3/32	3/16	6-32 x 1/4	.160	3/16	1 3/4	1 1/2	..	..	..	..
200	30	1 1/8	3/4	3/4	3/4	3/4	3/2	1 1/2	1 1/2	6-32 x 1/4	.172	3/8	1 1/2	1 3/4	1 3/8	1 3/8	1	1 1/2
300	24	1 3/8	3/8	1/2	3/8	3/4	3/4	3/2	3/2	8-32 x 3/8	.203	3/8	1 1/2	1 3/8	1 1/2	1 3/4	1	1 1/4
400	12	1 3/8	1 1/8	3/8	1 1/8	1 1/2	3/2	3/8	3/4	10-32 x 3/8	.190	..	2	2 3/8	..	..	..	..

100- & 6A100 SERIES

Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs
1	3/8	1 1/2	100	1	10	4 1/8	4 13/32	50	5	19	7 1/2	7 25/32	25	9	28	10 3/8	11 13/32	25	13
2	1 1/8	1 13/32	100	2	11	4 1/2	4 25/32	50	6	20	7 3/8	8 1/32	25	9	29	11 1/8	11 25/32	25	13
3	1 1/2	1 25/32	100	2	12	4 3/4	5 1/32	50	6	21	8 1/4	8 17/32	25	10	30	11 3/8	11 29/32	25	14
4	1 3/8	2 1/32	50	3	13	5 1/4	5 17/32	50	6	22	8 3/8	8 25/32	25	10	31	12	12 1/32	25	14
5	2 1/4	2 17/32	50	3	14	5 3/4	5 27/32	50	7	23	9	9 1/32	25	11	32	12 3/8	12 17/32	25	15
6	2 3/8	2 27/32	50	4	15	6	6 1/32	50	7	24	9 3/8	9 21/32	25	11	33	12 3/4	13 1/32	25	15
7	3	3 1/2	50	4	16	6 3/8	6 21/32	50	8	25	9 3/4	10 1/32	25	12	34	13 1/8	13 17/32	25	15
8	3 3/8	3 27/32	50	4	17	6 3/4	7 1/32	25	8	26	10 1/8	10 13/32	25	12	35	13 1/2	13 25/32	25	16
9	3 3/4	4 1/2	50	5	18	7 1/8	7 13/32	25	9	27	10 1/2	10 25/32	25	12	36	13 3/8	14 1/32	25	16

200 SERIES

Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs
1	3/8	1 3/8	100	4	9	4 3/8	4 13/16	50	13	17	7 3/8	8 3/8	25	22	25	11 3/8	11 13/16	25	30
2	1 3/8	1 3/8	100	4	10	4 13/16	5 1/8	50	14	18	8 3/8	8 3/8	25	23	26	11 13/16	12 1/8	25	32
3	1 3/4	2 1/8	100	5	11	5 1/4	5 5/8	50	15	19	8 3/4	9 1/8	25	24	27	12 1/4	12 3/8	25	33
4	2 3/8	2 1/2	50	7	12	5 13/16	6	50	16	20	9 3/8	9 1/2	25	25	28	12 13/16	13	25	34
5	2 3/8	2 13/16	50	8	13	6 1/8	6 3/8	50	17	21	9 3/8	9 13/16	25	26	29	13 1/8	13 3/8	25	35
6	3 3/8	3 3/8	50	9	14	6 3/8	6 3/8	50	18	22	10 3/8	10 3/8	25	27	30	13 3/4	13 3/8	25	36
7	3 1/2	3 13/16	50	10	15	7	7 3/8	25	20	23	10 1/2	10 13/16	25	28					
8	3 13/16	4 1/4	50	11	16	7 3/8	7 3/4	25	21	24	10 3/8	11 1/4	25	29					

300 SERIES

Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs
1	1 1/8	1 7/32	100	6	7	4 1/2	4 25/32	50	17	13	7 3/8	8 3/2	25	31	19	11 1/4	11 27/32	25	44
2	1 13/16	2 1/32	100	7	8	5 1/8	5 13/32	50	20	14	8 3/8	8 27/32	25	33	20	11 13/16	12 1/32	25	46
3	2 1/4	2 17/32	100	9	9	5 3/4	6 1/32	50	22	15	9	9 13/32	25	35	21	12 3/8	12 25/32	25	49
4	2 13/16	3 1/32	50	11	10	6 3/8	6 13/32	50	24	16	9 3/8	9 27/32	25	38	22	12 3/4	13 11/32	25	51
5	3 3/8	3 27/32	50	13	11	6 3/4	7 1/32	50	26	17	10 1/8	10 17/32	25	40	23	13 1/2	13 29/32	25	53
6	3 13/16	4 1/32	50	15	12	7 3/8	7 25/32	25	29	18	10 13/16	11 3/32	25	42	24	14 1/8	14 17/32	25	55

400 SERIES

Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs	Term	Mounting Length*	Overall Length*	Std Pkg	Shp Wt Lbs/c pcs
1	1 3/4	1 13/16	100	5	4	3 3/8	3 3/8	50	21	7	5 1/2	5 13/16	25	37	10	7 3/8	8	25	53
2	2 3/8	2 1/2	100	11	5	4 1/8	4 5/8	50	26	8	6 3/8	6 3/8	25	42	11	8 1/4	8 13/16	25	58
3	2 3/4	3 3/8	50	16	6	4 13/16	5 1/4	25	32	9	6 3/8	7 3/8	25	48	12	8 13/16	9 3/8	25	64

RATINGS

Block Series	Amps	Breakdown RMS Line to Line	Breakdown RMS Line to Ground	Max. Wire Size Comm. Terminal
100	15	5,200	8,400	14
200	20	6,800	10,000	12
300	30	9,000	11,200	10
400	50	10,000*	12,000	6

*Standard tolerances on fractional + 1/64", except for mounting and overall length where an additional tolerance of .002" per inch of length applies. We recommend using elongated mounting holes on panels. This will compensate for variations of molding compounds.

POOR ORIGINAL

(M) special products

021509

300 Series

TERMINAL BLOCK - DOUBLE ROW

*Refer to Bulletin 4.0 for Terminal Strip Ratings and Standards.



300 VOLTS - 30 AMPS* 1-24 TERMINALS

4

GENERAL INFORMATION

APPLICATION

Designed for electrical and electronic termination of wire, with or without use of a terminal connection, for low voltage and amperage requirements.

CONSTRUCTION

Terminals — Brass, nickel plated
 Base — General purpose phenolic rated 150°C closed back
 Screws — 8-32 Binder head

ELECTRICAL RATING

—300 Volt*
 —30 Amps*
 —Will accommodate lugs for wire sizes AWG #16 to #10
 —9/16" Centers

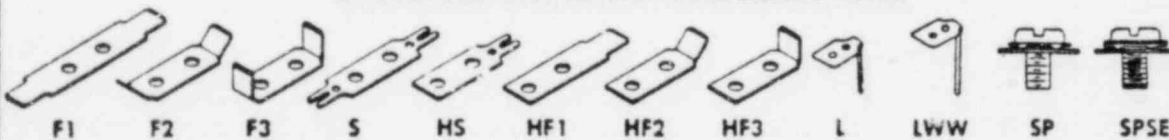
STANDARDS

U.L. Recognized File No. E62806
 C.S.A. Certified File No. 19766

CATALOG NUMBER

NO. OF TERM.	CAT. NO.	NO. OF TERM.	CAT. NO.	NO. OF TERM.	CAT. NO.
1	301	10	310	19	319
2	302	11	311	20	320
3	303	12	312	21	321
4	304	13	313	22	322
5	305	14	314	23	323
6	306	15	315	24	324
7	307	16	316		
8	308	17	317		
9	309	18	318		

STANDARD MODIFICATIONS DEFINITIONS



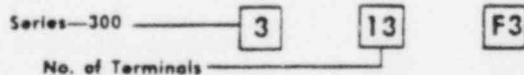
All 300 series standard modifications will take a .250" fast-on

F1 = Full quick connect (0° flat)
 F2 = Full quick connect (45° bend)
 F3 = Full quick connect (90° bend)
 S = Full solder (both sides)

HS = Half solder (one side)
 HF1 = Half quick connect (0° flat)
 HF2 = Half quick connect (45° bend)
 HF3 = Half quick connect (90° bend)

L = Feed thru solder connector
 LWW = Feed thru wire wrap
 SP = Sems pressure saddle screw (8-32 steel, nickel plated)
 SPSE = Sems pressure saddle screw with external tooth lock washer (8-32 steel, nickel plated)

ORDERING CODE



For use with modifications, see above code. Applies to same modifications all lines. Combination of modifications, consult factory.

Typical Cat. Number: Standard-313

Standard Modified-313-F3

MARATHON SPECIAL PRODUCTS

DIVISION OF MARATHON ELECTRIC
 BOWLING GREEN, OHIO 43402

POOR ORIGINAL

MEDIUM DUTY

021509

Making sense out of

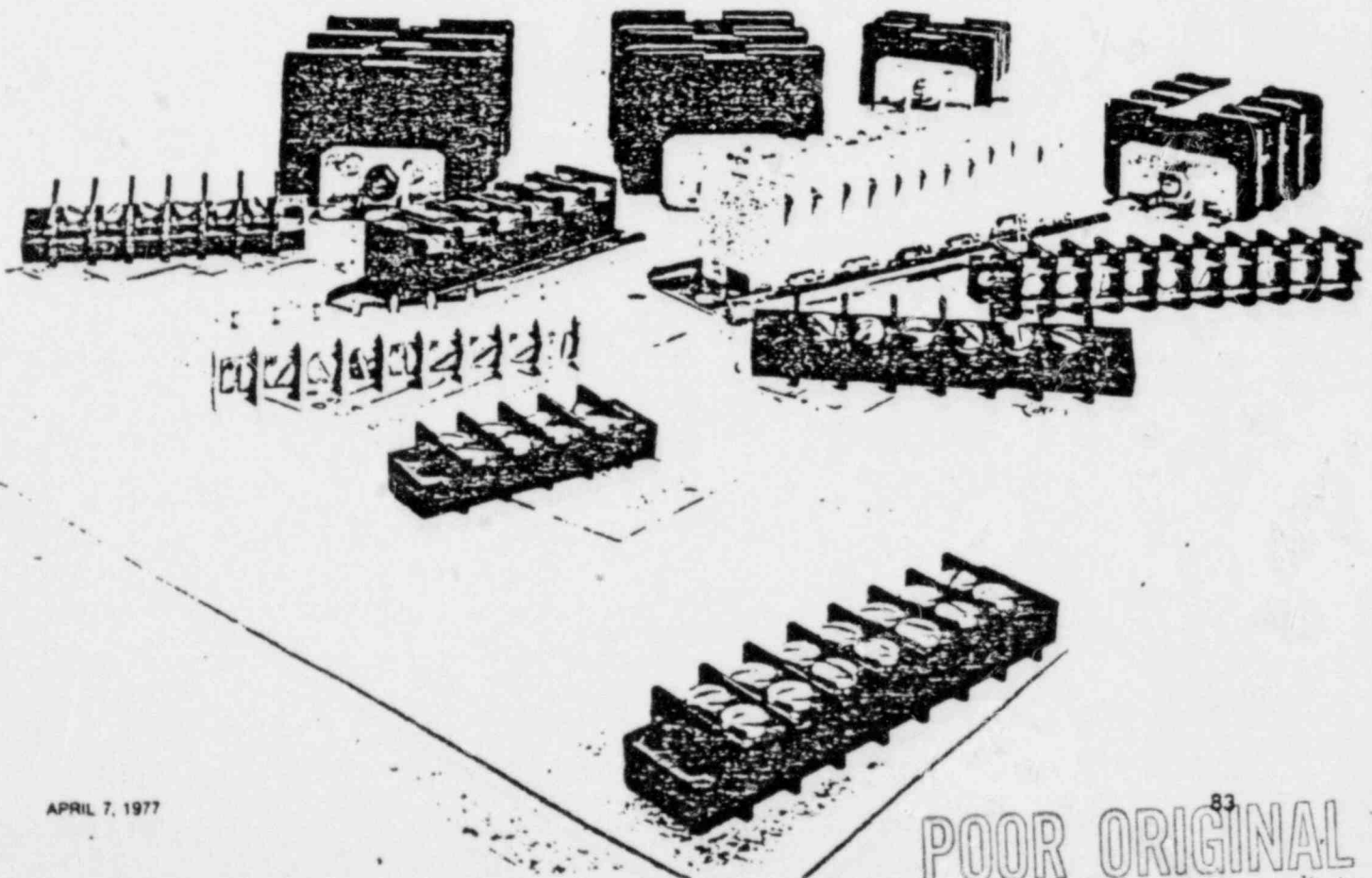
TERMINAL BLOCK RATINGS

Terminal blocks are perhaps the simplest devices in an electrical circuit. Yet, selection is often difficult because of nonstandardized rating methods. Here's how various manufacturers rate their blocks and what the ratings really mean.

RUSSELL J. VAN DER ELSSEN
Curtis Industries Inc.
Milwaukee, Wis.

Thousands of terminal block types are made by over 35 manufacturers who often assign widely differing ratings to virtually identical blocks. To effectively compare and select the devices, you must know how the voltage and current ratings were determined

THERE is no one U. S. nationally recognized standard for determining terminal block voltage and current ratings. Because many terminal block manufacturers use their own methods, the user is often faced with different ratings for virtually identical terminal blocks. For example, most terminal block manufacturers base operating-voltage ratings on one of two criteria: breakdown-voltage tests or terminal spacing. But operating-voltage ratings based on breakdown-voltage tests may be two to three times higher than those based on terminal spacing. Current ratings are equally difficult to assess because in many cases they are based on inconclusive data and temperature ratings of wire insulation types now seldom used in industry. Thus, competitive



terminal block data may not be directly comparable.

Agencies such as Underwriters Laboratories (UL) and the National Electrical Manufacturers Association (NEMA) are attempting to standardize terminal block ratings. For example, NEMA Standard IS 4-1968 is being updated to agree with the voltage ratings in UL Standard 1059.

Operating Voltage

A terminal block voltage rating indicates how much voltage can be applied across the terminals without danger over (arcing between terminals). Most terminal block manufacturers establish voltage ratings according to either breakdown voltage or terminal spacing.

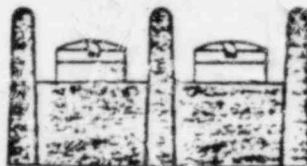
Breakdown voltage of the terminal block is determined by a hi-pot (high-potential) test in which the voltage difference between adjacent terminals is increased until current flashes between terminals or between a terminal and ground. The operating voltage rating is then established as a fraction of the breakdown voltage. Most manufacturers use one-third breakdown potential as the operating-voltage rating for blocks rated below 600 Vrms. The origin of this practice is not known for certain. However, it may have started with the UL and NEC (National Electrical Code) requirement that electrical equipment withstand a hi-pot test of twice the rated voltage plus 1,000 Vrms for 1 min. Thus, a 1,000-Vrms terminal block can withstand up to 3,000 Vrms without breakdown under test conditions. For blocks rated between 601 and 5,000 Vrms, NEMA Standard ICS-1970 requires a hi-pot test of 2½ times rated voltage plus 2,000 Vrms.

The major weakness of the

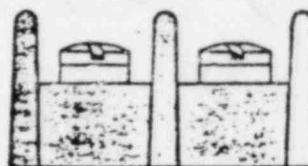
What's Creepage and Clearance?

Creepage and clearance are terminal block distances used by UL and NEMA to determine voltage ratings. Creepage is between-terminal and terminal-to-ground spacing measured along the surface of the insulation. This path is the same as that taken by an arc along the surface of the insulation during breakdown. Clearance is the shortest through-air distance between terminals and from terminals to ground. During breakdown, this current path is the alternative to that defined by creepage.

Creepage



Clearance



hi-pot method of determining operating voltage rating is the hi-pot test itself. An accurate high-voltage source is required—usually 5,000 to 10,000 Vrms—and test conditions such as moisture, surface contamination, and air quality must be carefully controlled to obtain repeatable results. But even with carefully controlled test conditions the resultant rated voltage is for a specific set of environmental conditions that cannot be controlled in application. However, many manufacturers continue to use this rating method because it usually yields a higher operating voltage rating than other methods.

If the test method is not given in a manufacturer's catalog, there are two ways to determine which method was used. If the operating voltage rating of one brand of terminal block is near one-third breakdown voltage and, at the same time, is unusually higher than the rating of a competitive terminal block, more than likely the operating voltage rating has been determined from hi-pot testing. Since

UL does not presently accept this method of determining terminal block voltage rating, another good indication of hi-pot testing is the absence of any mention of UL recognition in advertising or product literature. To be sure, however, contact the manufacturer. A terminal block may be recognized but may only meet spacing requirements for specific applications.

The terminal-spacing method of determining terminal block operating voltage ratings is based on distance measurement rather than a hi-pot test. The rating depends on two measurements (creepage and clearance) that represent paths that flash-over current follows during breakdown between adjacent terminals, or between terminals and ground. Creepage is the distance along the surface of the insulating material, and clearance is the distance through the air as measured from terminal to terminal or from terminal to ground.

UL tables correlate creepage and clearance distances within terminal block operating volt-

ages for UL recognition. UL Standard 1059 categorizes terminal blocks in three general areas according to intended use: Class A for service equipment such as switch boards and panel boards, Class B for commercial appliances such as business equipment and data processing equipment and Class C for general industrial applications.

Within each category, terminal blocks are rated according to creepage and clearance distances. For example, a terminal block rated at 240 Vrms has clearance and creepage requirements of $\frac{3}{4}$ in. and $1\frac{1}{4}$ in. respectively, for use in service equipment (Class A); $\frac{3}{32}$ and $\frac{3}{32}$ in. for use in a commercial appliance (Class B); and $\frac{3}{8}$ and $\frac{1}{2}$ in. for use in a general industrial application (Class C).

Because of the commercial significance of UL recognition, the terminal spacing method is being used increasingly by manufacturers. Moreover, UL requires that terminal blocks be UL recognized in UL-listed equipment. Because some metropolitan areas require the use of UL-listed equipment, the importance of UL recognition is be-

coming increasingly significant in industrial equipment.

At first glance, the difference in rating methods may seem immaterial. In reality, the results are significantly different. For example, one manufacturer may rate his block at one-third breakdown voltage, or 1,000 Vrms, indicating the unit withstood a hi-pot test of 3,000 Vrms. Another manufacturer, using the terminal spacing method, rates an identical block at 300 Vrms, but specifies a breakdown voltage of 5,500 Vrms. If the second manufacturer follows the breakdown voltage method, he could rate his block at 2,250 Vrms. Thus, the manufacturer using one-third breakdown voltage as the sole basis for voltage ratings may be rating his block two or three times higher than the manufacturer using the terminal spacing method.

Operating Current

According to the revised NEMA Standard IS 4-1976, terminal blocks should be able to carry as much current as the wires they are designed for

without exceeding a temperature rise of 30° C. Current ratings for wires are based on NEC tables 310-16 and 310-18. Unfortunately, terminal-block manufacturers' current ratings have been based on 60° C insulation ratings. Thus, the current ratings shown in many catalogs do not accurately indicate the true current capacity of the terminal block.

Accordingly, many terminal block manufacturers have removed current ratings from their published data and refer only to the wire range and the appropriate NEC tables. The only limiting factor here is that the temperature rating of the conductor should not exceed the temperature rating of the terminal block insulating material. Otherwise, the terminal block molding might melt at elevated temperatures. Thermoplastics used in terminal blocks are generally rated at 90° C or greater and thermoset material is rated at 150° C or greater. Since most wires used in industry are rated 90° C or less, there is little chance of terminal-block melting under normal service.

Usually, terminal blocks can be selected solely on the basis of voltage and current ratings. However, some specialized applications require the consideration of other characteristics.

- Sufficient mechanical strength to withstand stress or vibration.
- Flame retardancy of the insulation for most any application (UL requires a rating of 94V-1 or better).
- High dimensional stability for close tolerance applications where wide variations in temperature and humidity may cause physical distortion.
- High dielectric strength for low-current applications where current leakage must be minimized.

Terminal blocks used in UL-listed equipment must be recognized in accordance with the Safety Standard UL 1059. This standard categorizes terminal blocks in Class A, B, or C according to their intended use and terminal spacing. UL-recognition of terminal blocks is becoming increasingly important because of the commercial significance of UL listing.

Terminal Block Class	Operating Voltage Rating, Vrms	Terminal Spacing, in.	
		Clearance	Creepage
A. Service Equipment (dead-front switchboards, panel boards, etc.)	51 to 125	1/2	3/4
	126 to 250	3/4	1 1/4
	251 to 600	1	2
B. Commercial Appliances (business equipment, electronic data-processing equipment, etc.)	51 to 125	1/16	1/16
	126 to 250	3/32	3/32
	251 to 600	3/8	1/2
C. General Industrial (power distribution, signal routing, etc.)	51 to 150	1/8	1/4
	151 to 300	1/4	3/8
	301 to 600	3/8	1/2

LIMITORQUE CORPORATION

5114 Woodall Road • P. O. Box 11318 • Lynchburg, Virginia 24506

021509 Telephone—804-528-4400 • Telex—82-9448



ATTACH.-2

January 21, 1981

Henry Pratt Company
401 South Highland Avenue
Aurora, IL 60507

Attention: Mr. K. Wilson

Gentlemen:

Subject: Marathon 100 Series Terminal Strips

In response to the recent report from the Bechtel personnel at the Midland Power Station site, we have researched our records and found that the equipment in question was modified by a Limatorque field service engineer in November of 1977. At this time, 66 sets of terminal strips were supplied by our factory in Lynchburg for a field service engineer to change terminal strips at the jobsite. According to our records, the proper voltage rated terminal strips were shipped at this time.

After the field service engineer arrived at the jobsite, he discovered that some of the terminal strips shipped had been damaged. An additional 20 terminal strips were shipped from the Lynchburg plant. These were 140 series terminal strips manufactured by Cinch Jones which are dimensionally the same as Marathon 100 terminal strips. These strips were to be used only in the 120 volt control circuit and not for the power connection. The field service engineer that performed the required terminal strip changes was a new employee and did not know at the time that the Cinch Jones terminal strips were not adequate to be used for power connections.

At my request, Mr. Gary Warner removed terminal strips from several operators and found that the terminal strip on one unit from

021509 Mr. K. Wilson
January 21, 1981

Limitorque Order 393688-A was a Cinch Jones 140 series terminal strip. In addition, on a unit furnished on Limitorque Order 3A2337-B, Mr. Warner found a terminal strip which appeared to be a Marathon 100. In examining our records, we have found that the Marathon 100 terminal strip has never been a stock part with Limitorque nor have we found any record of having purchased any Marathon 100 series terminal strips.

Enclosed is a copy of our field service report for changing the terminal strips at the jobsite. This report includes records of the order numbers and serial numbers of the equipment worked on and shipping papers on the parts shipped from our Lynchburg plant. After studying all the available data, we have concluded that this is an isolated incident attributable to the inexperience of a field service engineer. We have not been able to determine where the Marathon 100 terminal strips came from, but it is possible that the field service engineer obtained these strips locally at the jobsite. Limitorque will provide a field service engineer and the appropriate parts to rework the 66 units originally field modified.

Please contact me if we can be of further assistance.

Very truly yours,

LIMITORQUE CORPORATION

Daniel S. Warsing
Daniel S. Warsing
Technical Manager

jhb

Enclosure

cc: F. K. Denham
P. G. McQuillan
Vajay Shah/Bechtel Power Corp.

LIMITORQUE CORPORATION

ROUTE TO	11/80*
M.C.D.	1/11
F.D.	—
W.D.	1/31
SERVICE ORDER FILE	

~~021588~~ SERVICE CALL REPORT RECEIVED

DEC 20 1977
LIMITORQUE CORP.

CUSTOMER NAME HENRY PRATT CO.
 FULL LOCATION OF JOBSITE CONSUMERS POWER CO.
MIDLAND, MICHIGAN

CONTACT: MR. DWANE DUCKERING, CO. BECHTEL CORP. TITLE ELECTRICAL ENGINEER
 MR. BRAD STODDER, CO. BECHTEL CORP. TITLE ELECTRICAL ENGINEER

REPAIR ORDER # 388346 ORIGINAL ORDER # 392357A to E ^{File} 392356A,B,C 393686A,B,C
393687A+B 393688A 394135A TO E

QUANTITY & TYPE OF UNITS 12 SMA-00 48 SMA-000
 DEPART WILLOWBROOK, ILL. DATE NOV 21, 1977 TIME 11:00
 ARRIVE MIDLAND, MICHIGAN DATE NOV 21, 1977 TIME 4:30
 DEPART MIDLAND, MICHIGAN DATE DEC 1, 1977 TIME 3:30
 ARRIVE CAROL STREAM, ILL. DATE DEC 1, 1977 TIME 9:00

TOTAL SERVICE HOURS 55 1/2 TRANSPORTATION AIR, RENTAL CAR, PERSONAL CAR

PROBLEM DESCRIPTION WRONG TERMINAL STRIPS INSTALLED AT LYNCHBURG

PARTS REPLACED TERMINAL STRIPS SUPPLIED BY LYNCHBURG

ACTION TAKEN REMOVE EXISTING TERMINAL STRIPS AND MOUNTING BRACKETS ON THE SMA-000'S. MOUNT THE NEW TERMINAL STRIPS BY DRILLING AND TAPPING NEW HOLES, REMOUNT MOUNTING BRACKETS AND TERMINATE WIRES. ON THE SMA-00'S REMOVE EXISTING TERMINAL STRIPS AND DRILL OUT TWO HOLES LARGER TO TAP FOR A 1/4 X 20 SCREW TO HOLD DOWN THE NEW TERMINAL STRIP AND MOUNTING BRACKET AND TERMINATE WIRES.

IS JOB WARRANTY (check one) YES NO
 WHY WARRANTY PER CHARLES FREMICA

[USE SUPPLEMENTAL SHEET WHEN NEEDED]
 12-19-77

Keith R. Kehring
 SIGNED

SERVICE CALL REPORT

CUSTOMER HENRY PRATT CO 021505 JOB #388346 SUPPLEMENTARY SHEET #/

LEFT JOB SITE THURSDAY DECEMBER 1, 1977 THERE
WERE THREE UNITS LEFT TO DO. TWO OF THE UNITS WERE
MOUNTED IN A POSITION IN WHICH THE LIMIT SWITCH COVER
COULD NOT BE REMOVED. THE LAST UNIT THE ELECTRICIANS
WERE GOING TO DO FRIDAY MORNING DECEMBER 2, 1977.

BRAD STODDER SAID THAT THIS WAS ALL THE UNITS
TO BE DONE.

021509

LIMITORQUE
ORDER NO.

VALVE TAGGING

393686 A

1M0 - 1903R ✓
-1907R ✓

2M0 - 1933R ✓
1937R ✓

393686 B

1M0 - 1908 RP ✓
-1911 RP ✓
1915 RP ✓
1918 RP ✓

2M0 - 1940 RP ✓
1943 RP ✓
1947 RP ✓
1950 RP ✓

393686 C
393687 A

2M0 - R - P
1M0 - 1978R ✓
1980R ✓

2M0 - 1982R ✓
1984R ✓

393687 B
393688 A

2M0 - R
1M0 - 1847R ✓
-1842R ✓

2M0 - 1852R ✓
-1856R ✓

394135 A

1M0 - 1610 - A - R ✓
1610 - B - R ✓
1710 - A - R ✓
1710 - B - R ✓

394135 B

1M0 - 1620 - A - R ✓
1620 - B - R ✓

394135 C

1M0 - 1607 - BR ✓
2M0 - 1707 - AR ✓
1707 - BR ✓

394135 D

M0 - 1720 AR ✓
1720B - R ✓

394136 E

1M0 - 1607 - A - R ✓

LIMITORQUE
ORDER NO

021509

VALVE TAGGING

3A2336A

OMO - 1819R ✓
1826 - 1R ✓
1826 - 2R ✓
1826 - 4R ✓
1809 - R ✓

3A2336B

OMO - 1810R ✓
1820R ✓

3A2336C

1MO - 1843R ✓
1857R ✓

3A2337A

2MO - 1848R ✓
- 1858R ✓

3A2337B

1MO - 1685A-R ✓
2MO - 1785A-R ✓
1MO - 1687R ✓

3A2337C

2MO - 1787R ✓
1MO - 1685-B-R ✓
- 1623A-R ✓
- 1623-B-R ✓
2MO - 1723AR ✓
1723 BR ✓
1785 B-R ✓

3A2337D

OMO - 3893A-R ✓
3893 B-R ✓
3993AR ✓
3993 B-R ✓

P.O. # 7220 - M132 AC

Nov. 22, 1972 TUES 021509

SIZE	ORDER	SERIAL	PUT IN JUMPER
JMB -00	3A2336A	245757	
00	"	54	
000	393686C	237943	✓
000	393686C	237945	✓
000	393686B	237930	✓
000	393686C	237948	✓
000	393686B	237952	✓
000	393686B	237926	✓
000	393686B	237929	✓
000	393686B	237931	✓
000	393686B	237933	✓
00	3A2336A	245756	
00	3A2336A	245753	
000	393686B	237932	✓
000	393686C	237946	✓
000	393686B	237933	✓
00	393686A	238271	
00	393686A	238270	
000	394135C	236190	✓
000	393688A	237959	✓
000	393686C	237942	✓
000	393688A	237958	✓
000	393686C	237947	✓
000	393687A	237977	✓
000	3A2337A	246051	✓
00	394135A	236095	

7971 911

[Handwritten signature]

[Handwritten initials]

021509

SIZE	ORDEC	SERIAL	PUT IN JUMPER
MB-000	393687A	237980	✓
000	393687A	237978	✓
000	3A2337B	246578	✓
000	393686C	237744	✓
000	393688A	237961	✓
000	393688A	237960	✓
000	393687B	237986	✓
000	393687B	237988	✓
000	3A2357A	246050	✓
000	394135D	236169	✓
000	3A2357D	246054	✓
000	3A2337D	246057	✓
000	394135C	236189	✓
000	393687A	237979	✓
000	393687B	237987	✓
000	393687B	237985	✓
00	393686A	238273	
00	393686A	238272	
000	394135B	236166	✓
000	394135D	236170	✓
00	394135A	236094	
000	3A2337A	246581	✓
000	3A2337C	246582	✓
000	394135B	236165	✓
000	394135C	236188	✓
000	394135E	236173	✓
000	3A2337D	246055	✓

54 SO FILE

021509

SIZE

ORDER

SERIAL

PUT IN
NUMBER

00 394135A 236093

000 3A2337B 246577 ✓

000 3A2337C 246586 ✓

000 3A2337D 246056 ✓

00 394135A 236096

000 3A2337C 246584 ✓

L.S COVER ~~W~~ CANT COME OFF PIPE IN WAY

000 3A2337C 246585

000 3A2337C 246583

BEAD STODDER SAYS ONE VALVE AND OPERATOR NOT RELIEVED YET
ELECTRICIANS WILL DO LAST ONE IN PUMP HOUSE MORNING 12-2-77

12-SMB-00

48 SMB-000

LIMITORQUE CORPORATION

14234

SHIPPING LIST

5114 WOODALL ROAD

LYNCHBURG, VIRGINIA 24502

Ordered by

021509

Date 11-15-77

Address

Consigned to
 Limitorque Corporation
 101 E. Midway Drive
 Willowbrook, Illinois 60521
 Address
 Attn: Jim Enders

Our Order 3B8346-B Your Order
 Express Coll. - Ppd. Freight - Route 0025-2700
 P.P. XXXXX Ppd. J.B. Moore Del'd


No. Boxes No. Crates No. Skids No. Pkgs. 1 Gross 19# Weights Net

Dimensions Partial ~~XXXXXX~~ Shipment Packed by

QUAN.	CONTENTS
	Item B Code 8-000-000-000
1	Lot of Parts
	66 - Sets of Term. Straps No Charge
	Ref: SMB-000/00/0

Tri-City AIP
M. DEAND MICH
 012 DCA 0025
 -2954
 N.W. AIL
 #323 DETROIT
 #329 DETROIT MICH.
 ARRIVE 6:40

CARRIER REMARKS	
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B/A	WEIGHT CHARGES	PICKUP ZONE	PICK UP CHARGES	DEL. ZONE	DELIVERY CHARGES	ORIG. ADV. CHGS.	DESCRIPTION OF ORIGIN ADVANCE CHARGES
D	EXCESS VALUE	DEST. ADV. CHGS.	DESCRIPTION OF DEST. ADVANCE CHARGES		OTHER CHARGES	DESCRIPTION OF OTHER CHARGES	
I	TAX	SHIPPER'S C. O. D.	C. O. D. FEE	SHIPPER'S R. F. C.	1ST RATE	2ND RATE	3RD RATE
R	SHIPPER PAYS	ITEMS PREPAID	CONSIGNEE PAYS	ITEMS COLLECT			

THIS IS NOT AN INVOICE

THIS SHIPMENT HANDLED IN INTER MODAL TRANSPORTATION

EXECUTED BY <i>RJ Bowling</i>	DATE <i>11/15/77</i>	TIME <i>4:25 PM</i>	CARRIER <i>J.B. Moore</i>	ORIGIN	SERIAL NUMBER <i>0025-2700</i>
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LIMITORQUE CORPORATION

15615

SHIPPING LIST

5114 WOODALL ROAD

LYNCHBURG, VIRGINIA 24502

Ordered by Henry Pratt Co. Date 11-28-77
 Address 401 S. Highland Avenue
Aurora, Ill. 021509

Consigned to Tri-City Airport
Midland, Michigan
 Address HOLD FOR PICKUP BY
KEITH KERING

Our Order 388346-B Your Order Verbal J. Collison Req. 0025-2954

P.P. Express Coll. - Ppd. Freight - Route 0025-2954
XXXX - Ppd. J.B. Moore Air Frt. Del'd.

No. Boxes No. Crates No. Skids No. Pkgs. 1 Gross 2# Weights
 Net

Dimensions Partial or XXXXXX Shipment Packed by

QUAN.	CONTENTS
	Item B Code 8-000-000-000 CX
20	7 Point cinch Jones Term. Strips
	NO CHARGE REF: SMB-000

Flight: <u>323</u>		- <u>217</u>	
 		 	
left: <u>7:17</u>		<u>452</u>	
arrive: <u>9:15</u>		<u> </u>	
CARRIER REMARKS			

B/	WEIGHT CHARGES	PICKUP ZONE	PICK UP CHARGES	DEL. ZONE	DELIVERY CHARGES	ORIG. ADV. CHGE.	DESCRIPTION OF ORIGIN ADVANCE CHARGES
A	EXCESS VALUE	DEBT. ADV. CHGE.	DESCRIPTION OF DEBT. ADVANCE CHARGES		OTHER CHARGES	DESCRIPTION OF OTHER CHARGES	
D	TAX	SHIPPER'S C. O. D.	C. O. D. FEE	SHIPPER'S R. F. C.	NET RATE	2ND RATE	3RD RATE
I	SHIPPER PAYS	ITEMS PREPAID	CONSIGNEE PAYS	ITEMS COLLECT	Air Freight		

THIS IS NOT AN INVOICE

THIS SHIPMENT HANDLED IN INTER MODAL TRANSPORTATION

EXECUTED BY <u>J.B. Moore</u>	DATE <u>11-28-77</u>	TIME <u>350</u>	CARRIER <u> </u>	ORIGIN <u> </u>	SERIAL NUMBER <u>0025-2954</u>
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SHADED AREA FOR