interoffice

MEMORANDUM

to: Dr. Rosanne Williamson

from: Kimberly Ptak

re: FOIA Request – Steam Traps

date: January 17, 2012

Attached is documentation of the conversion from steam traps to steam misers which occurred between 1982 and 1983. This is all of the documentation we have on the steam trap systems at GBN. The attached documents include shop drawings and locations of the steam misers. The system is referred to in these documents as a "STEAMGARD" system.

from the desk of...
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8750 West Bryn Mawr Avenue
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NICHOLAS KAY

BILL DIMITRIADIS
Mechanical Engineer
Technical Services

need steam to
coil - reheaters
Converted to
95' steam misers

ENGINEERING RESOURCES, INC.
Presidents Plaza Three
8750 West Bryn Mawr Avenue
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GLENBROOK NORTH HIGH SCHOOL

BILL OF MATERIALS

QUANTITY	SIZE/MODEL	LOCATION	PRICE EACH	TOTAL AMOUNT
4	1/2" SG-R-07	Convectors at Caged Area	$78.40	$ 316.60
3	1/2" SG-R-07	For Main Gym	78.40	235.20
1	1.0" SG-B-13 System	AHU Outside Mr. Archer's Office	350.00	350.00
1	1.0" Strainer	AHU at Supply Room	34.00	34.00
1	3/4" Blowdown Valve		18. 00	18.00
1	3/4" SG-B-05 System	Drip at the Tunnel	175.00	175.00
		TOTAL:		$1,125.80

PURCHASE ORDER #369 MN – GIVEN BY MR. FLOYD ARCHER, MAINTENANCE SUPERVISOR, GLENBROOK NORTH HIGH SCHOOL.

BD:sw
7/7/87

Page

1

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

06/23/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10005
REVISION LETTER 'B'
SHEET 01 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> POOL TUNNEL <<

1 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-05 (9-82 ~~6B~~)
(1) --3/4 MH F #17 TAG # 1 DRIP - 2" X 112 LF 1" MAGNESIA # ALL DRIPS SIZED FOR CONTINUOUS OPERATION

2 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-06 (9-82 ~~11A~~)
(1) --3/4 MH F #17 TAG # 2 DRIP - 8" X 104 LF 1" GF

3 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-04 (~~13A~~)
(1) --3/4 MH F #17 TAG # 3 DRIP - 3" X 12 LF + 6" X 4 LF 1" GF

4 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-05 (~~6B~~)
(1) --3/4 MH F #17 TAG # 4 DRIP - 6" X 30 LF + RISER 1" GF

5 POOL TUNNEL IN<BK> = 9< -3> PSIG (NOT APPLICABLE)
(1) --3/4 MH F #17 TAG # 5 DRIP - 10" X 250 LF (MAIN) 1" GF "INSTALLED (1) 3/4" SG-A-12 (10D)"

Shipa B-?

6 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-06 (11A)
(1) --3/4 MH F #17 TAG # 6 DRIP - 6" X 105 LF (MAIN) 1" GF

7 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-07 (10-82 ~~7B~~)
(1) --3/4 MH F #17 TAG # 7 DRIP - 6" X 176 LF (MAIN) 1" GF

8 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-05 (10-82 ~~6B~~)
(1) --3/4 MH F #17 TAG # 8 DRIP - 3" X 50 LF 1" GF

9 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-07 (6-82 ~~7B~~)
(1) --3/4 MH F #17 TAG # 9 DRIP - 6" X 200 LF (MAIN) 1" GF

10 POOL TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-05 (6-82 ~~6B~~)
(1) --3/4 MH F #17 TAG # 10 DRIP - 4" X 16 LF + RISER 1" GF

5 1½ R 1½"

3units

6.8" A 10' XTH 1½

2

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

06/23/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10005
REVISION LETTER 'B'
SHEET 02 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> MECHANICAL ROOMS FOR POOL <<

```
11 POOL PUMP ROOM          IN<BK> =    9<  -3> PSIG      (1) 1.0 SGL-A-23   (15F)
   (1) 2---- MH F                  CONVERTOR - SHELL 14" D X 33" L RECIRC 75 DEG F OUT  PUMP 350 GPM

12 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 1.0 SG -A-16   ( 8D)
   (1) 2---- -- F       TAG # 15   AHU - COIL 36" X 90" X 3" DEEP  PREHEAT

13 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 1.0 SG -A-09   ( 7C)
   (1) 1-1/2 -- B       TAG # 17   AHU - COIL 20" X 41" X 3/4" COPPER TUBING  (SERPENTINE)

14 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 3/4 SG -A-09   ( 7C)
   (1) --3/4 -- B       TAG # 17   AHU - COIL 20" X 48" X 3/4" COPPER TUBING  (SERPENTINE)

15 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 3/4 SG -A-09   ( 7C)
   (1) --3/4 -- B       TAG # 18   AHU - COIL 20" X 48" X 3/4" COPPER TUBING  (SERPENTINE)

16 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 3/4 SG -A-04   (13A)
   (1) --3/4 -- B       TAG # 19   DRIP -  3" X  16 LF  1" GF

17 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 3/4 SG -A-05   ( 6B)
   (1) --3/4 -- B       TAG # 20   DRIP -  6" X  50 LF  1" GF

18 POOL FAN ROOM           IN<BK> =    9<  -3> PSIG      (1) 3/4 SG -A-09   ( 7C)
   (1) --3/4 -- B       TAG # 21   AHU - COIL 20" X 48" X 3/4" COPPER TUBING  (SERPENTINE)
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3

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

06/23/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10005
REVISION LETTER 'B'
SHEET 03 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> MAIN GYM FAN ROOMS <<

7-82

19 GYM FAN RM NORTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-05 (~~[illegible]B~~)
(1) 1---- -- F TAG # 1 DRIP - 5" X 60 LF 1" GF

20 GYM FAN RM NORTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-15 (~~23~~A)
(1) 1-1/2 -- F TAG # 2 AHU - COIL 26" X 72" PREHEAT (1) ROW X (2) COILS COIL #1

21 GYM FAN RM NORTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-15 (~~23~~A)
(1) 1-1/2 -- F AHU - COIL 26" X 72" PREHEAT (1) ROW X (2) COILS COIL #2

22 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-14 (~~17~~A)
(1) 1---- -- F TAG # 4 AHU - COIL 28" X 53" ~~PREHEAT~~ RH

23 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 3/4 SG -A-06 (~~11~~A)
(1) --3/4 -- - TAG # 5 DRIP - 6" X 160 LF 1" GF

24 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-15 (~~23~~A)
(1) 1-1/2 -- - TAG # 6 AHU - COIL 26" X 78" PREHEAT (1) ROW X (2) COILS COIL #1

25 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-15 (~~23~~A)
(1) 1-1/2 -- - AHU - COIL 26" X 78" PREHEAT (1) ROW X (2) COILS COIL #2

26 GYM FAN RM SOUTH IN<BK> ~~=~~ ne 9< -3> PSIG (1) 1.0 SG -A-14 (~~17A~~)
(1) 1-1/2 -- - TAG # 7 AHU - COIL 26" X 66"

9-87
27 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-14 (1~~7A~~)
(1) 1-1/2 -- - TAG # 8 AHU - COIL 26" X 66"

9-87
28 GYM FAN RM SOUTH IN<BK> = 9< -3> PSIG (1) 1.0 SG -A-11 (1~~3~~C)
(1) 1-1/2 -- - TAG # 9 AHU - COIL 20" X 41"

North Gym
1 Gym Fan Rm - North H 345 Model
Modine
~~Herman Nelson~~
Tag #24
16 X 16 9<-3>

Tag #3 22 X 43 9<-3>
Reheat Coil

Tag #4 south 16X6 345
Modine

By Pass 16 X 58

4

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

06/23/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10005
REVISION LETTER 'B'
SHEET 04 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> GYM FAN ROOMS <<

9-82

```
29 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 1.0 SG -A-17   ( 8E)
   (1) 1-1/2 -- F      TAG # 1   AHU - COIL 36" X 108"  PREHEAT

30 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-04   (13A)
   (1) --3/4 -- B      TAG # 2   DRIP -  3" X  30 LF  1" GF   Need

31 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-08   (15A)
   (1) --3/4 -- B      TAG # 3   AHU - COIL 13" X  26"  Drip

32 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 1.0 SG -A-15   (23A)
   (1) 1-1/2 -- F      TAG # 4   AHU - COIL 30" X 72"

33 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG  Need (1) 1.0 SG -A-15   (23A)
   (1) 1-1/2 -- F      TAG # 5   AHU - COIL 30" X 72"   Drip

34 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-03   ( 8A)
   (1) --3/4 -- -      TAG # 6   DRIP -  3" X   6 LF  1" GF

35 FAN RM "E" - SOUTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-08   (15A)
   (1) --3/4 -- -      TAG # 7   AHU - COIL 16" X  18"

36 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 1.0 SG -A-17   ( 8E)
   (1) 1-1/2 -- -      TAG # 1   AHU - COIL 36" X 108"  PREHEAT

37 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-04   (13A)
   (1) --3/4 -- -      TAG # 2   DRIP -  3" X  30 LF  1" GF

38 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-08   (15A)
   (1) --3/4 -- -      TAG # 3   AHU - COIL 13" X  26"
                                                               10-8
39 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 1.0 SG -A-15   (23A)
   (1) --3/4 -- -      TAG # 4   AHU - COIL 30" X 72"

40 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-15   (23A)
   (1) 1-1/2 -- F      TAG # 5   AHU - COIL 30" X 72"

41 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG $38 (1) 3/4 SG -A-03   ( 8A)
   (1) --3/4 -- -      TAG # 6   DRIP -  3" X   6 LF  1" GF

42 FAN RM "E" - NORTH     IN<BK> =   9<  -3> PSIG   (1) 3/4 SG -A-08   (15A)
   (1) --3/4 -- -      TAG # 7   AHU - COIL 16" X  18"
```

OK

5

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

03/03/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10205
REVISION LETTER ~~"D"~~ E
SHEET 01 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

1 BOILER ROOM IN<BK> = 9< -2> PSIG (1) 1.0 SG -~~B-0~~ 6-82
(1) 1 IN. -- - TAG # 52 DRIP - 10" X 40 LF TOTAL OF 2 LINES FIRST DRIP END OF LINE

2 BOILER ROOM IN<BK> = 9< -2> PSIG (1) 1.0 SG -~~B-0~~ 6
(1) 1 IN. -- - TAG # 53 DRIP - 10" X 40 LF TOTAL OF 2 LINES FIRST DRIP END OF LINE

3 BOILER ROOM IN<BK> = 9< -2> PSIG (1) 1.0 SG ~~-B-1~~ 6-82
(1) 1-1/4 -- - TAG # 54 VERT UH - 40"DIA + 3" X 30 LF DRIP MODINE V-2060 BAD TRAP

4 BOILER ROOM IN<BK> = 5< 0> PSIG (1) 1.0 SG -~~B-2~~ 7-82
(1) 2 IN. -- - TAG # 55 HEX - 20"DIA X 118"L 400 GPM 40 F DIFFER. 2330 LB/HR "SHIPPED"

5 BOILER ROOM IN<BK> = 5< 0> PSIG (1) 1.0 SG -~~B-2~~ 7-8
(1) 2 IN. -- - TAG # 56 HEX - PART OF ABOVE PARALLEL TRAP RADIANT HEATING "SHIPPED"

6 BOILER ROOM IN<BK> = 5< 0> PSIG (1) 1.0 SG -B-2
(1) 2 IN. -- - TAG # 57 HEX - PART OF ABOVE PARALLEL TRAP "SPARE TRAP" RADIANT HEATING

7 BOILER ROOM IN<BK> = 9< -2> PSIG (1) 3/4 SG -~~B-0~~ 6-8
(1) --3/4 -- - TAG # 58 DRIP - 10" X 90 LF SECOND DRIP TO TUNNEL

8 CHILLER ROOM IN<BK> = 9< 0> PSIG (1) 3/4 SG -~~B-0~~ 6-8
(1) --3/4 -- - TAG # 59 DRIP - 10" X 50 LF BEFORE HEX PRV'S BAD TRAP

9 CHILLER ROOM IN<BK> = 9< -2> PSIG (1) 3/4 SG ~~-B-0~~ 6-82
(1) --3/4 -- - TAG # 60 DRIP - 8" X 10 LF END OF FEED TO HEX PRV

10 CHILLER ROOM IN<BK> = 9< 0> PSIG (1) 1.0 SG -B-~~2~~ 6-8
(1) 2 IN. -- - TAG # 61 DOM HW HTR - 12600 GAL/HR 40/140 F 26000 EDR EA ELEMENT (2) ELEMENTS (1ST ELEMENT)

11 CHILLER ROOM IN<BK> = 9< 0> PSIG (1) 1.0 SG -B-2
(1) 2 IN. -- - TAG # 62 DOM HW HTR - PART OF ABOVE ~~SECOND~~ FIRST ELEMENT (2ND TRAP)

12 CHILLER ROOM IN<BK> = 9< 0> PSIG (1) 3/4 SG ~~-B-0~~ 6-82
(1) --3/4 -- - TAG # 63 DRIP - 8" X 10 LF END OF FEED TO HEX PRV

13 CHILLER ROOM IN<BK> = 9< 0> PSIG (1) 1.0 SG -B-~~2~~ 6-8
(1) 2 IN. -- - TAG # 64 DOM HW HTR - SECOND ELEMENT (1ST TRAP)

UPDATE 14 CHILLER ROOM IN<BK> = 9< -2> PSIG REQUIRE (1) ~~3/4~~ 1" SG -B-~~0~~ 2
(1) 2 IN. -- - TAG # 65 DOM HW HTR - PART OF ABOVE SECOND ELEMENT (2ND TRAP)

15 C R OVER HOT WTR TNK IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-0
(1) --3/4 -- - TAG # 66 DRIP - 4" X 20 LF END OF LINE FEED TO PRV

16 CHILLER ROOM IN<BK> = 9< -2> PSIG (1) 1.0 SG -B-~~2~~ 6-82
(1) 2 IN. -- - TAG # 67 HEX - B&G SU-124-6 40/180 F DISHWASHER 2112 GAL/HR 6000 EDR CALC EDR 2560

6

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

07/29/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

use "E"

PROPOSAL #10205
REVISION LETTER ~~[illegible]~~
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

17 CHILLER ROOM IN<BK> = 9< -2> PSIG (1) 1.0 SGL-B-21
(1) 2---- -- - TAG # 68 HEX - PART OF ABOVE PARALLEL TRAP "SPARE TRAP"

18 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-08
(1) --3/4 -- - TAG # 69 DRIP - 10" X 170 LF CONTINUOUS OPERATION BY E WINTER SECTION

19 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-~~09~~ 7-82
(1) --3/4 -- - TAG # 70 DRIP - 10" X 220 LF CONTINUOUS OPERATION

20 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B~~-08~~ 7-82
(1) --3/4 -- - TAG # 71 DRIP - 3" X 390 LF CONTINUOUS OPERATION BAD TRAP

21 TUNNEL NR DOOR EXIT IN<BK> = 9< -2> PSIG (1) 3/4 SG -B~~-07~~ 7-82
(1) --3/4 -- - TAG # 72 DRIP - 10" X 230 LF CONTINUOUS OPERATION VERIFY

22 TUNNEL NR DOOR EXIT IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-05
(1) --3/4 -- - TAG # 73 DRIP - 6" X 30 LF APPROX

23 TUNNEL IN<BK> = 9< -2> PSIG (1) 1.0 SG -B-~~07~~ 7-82
(1) 1---- -- - TAG # 74 DRIP - 10" X 230 LF + 6" X 120 LF CONTINUOUS OPERATION BAD TRAP

24 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -~~B-07~~ 7-82
(1) --3/4 -- - TAG # 75 DRIP - 6" X 30 LF END OF LINE BAD TRAP

25 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-05
(1) --3/4 -- - TAG # 76 DRIP - 1-1/2" X 100 LF, ASSUMED DRIP TO BIG GYM/GIRLS LOCKER RM

26 TUNNEL INTERSECTION IN<BK> = 9< -2> PSIG (1) 3/4 SG -B~~-09~~ 781
(1) --3/4 -- - TAG # 76 DRIP - 10" X 300 LF CONTINUOUS OPERATION TRAP REMOVED IN ERROR "INSTALLED 10 D"

27 TUNNEL INTERSECTION IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-07
(1) --3/4 -- - TAG # 78 DRIP - 4-1/2" X 300 LF END OF LINE FEED FROM POOL AREA

28 TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-05
(1) --3/4 -- - TAG # 79 DRIP - 4" X 30 LF APPROX NEAR TAG #5

29 POOL TUNNEL IN<BK> = 9< -2> PSIG (1) 3/4 SG -B-00 [illegible]
(1) --3/4 -- - TAG # 80 LOAD UNKNOWN

7

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10428
REVISION LETTER 'A'
SHEET 01 OF SHEET 01

GLENBROOK NORTH HIGH SCHOOL

>> FAN ROOM A & CRAWL SPACE AREA <<

```
 1 CRAWL SPACE             IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-06
   (1) --3/4 -- -      TAG #150  DRIP - 2" X 100 LF + 3" X 150 LF  END OF LINE SG-B-06 REQUIRES INSTALLATION  OR 1" 19A

 2 CRAWL SPACE             IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-04
   (1) --3/4 -- -      TAG #151  DRIP - 2" X 15 LF  END OF LINE  NOT USED  AHU

 3 CRAWL SPACE             IN<BK> =   9<  -3> PSIG              (1) 1.0 SG -B-09
   (1) 1---- -- -      TAG #152  DRIP - 8" X 400 LF EST  BAD TRAP  END OF BOILER FEED TO AREA       OR 1" 17A

 4 CRAWL SPACE             IN<BK> =   9<  -3> PSIG      (NOT APPLICABLE)
   (1) --3/4 MH D  2-4 TAG #153  AHU - TRANE UNIVENTILATOR SIZE 50.  NOT USED.  NO DRIP.  RECOMMEND DRIP OR VALVE.

 5 CRAWL SPACE             IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #154  DRIP - 2" X 60 LF  FEED TO UPSTAIRS.  TRAP PLUGGED.

 6 CRAWL SPACE             IN<BK> =   9<  -3> PSIG              (1) 1.0 SG -B-08
   (1) 1---- -- -      TAG #155  DRIP - 6" X 200 LF + 4" X 80 LF  END OF LINE  NEAR TAG #150

 7 AFTER SHUT-OFF          IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #156  DRIP - 6" X 75 LF + 4" X 125 LF TUNNEL

 8 OPPOSITE BELOW          IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #157  DRIP - 3" X 150 LF + 2" X 50 LF  END OF LINE  TUNNEL

 9 SIDE TUNNEL TAKE-OFF    IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-06
   (1) --3/4 -- -      TAG #158  DRIP - 3" X 130 LF + 2" X 160 LF  END OF LINE  TUNNEL

10 FAN ROOM A              IN<BK> =   9<  -3> PSIG              (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #159  DRIP - 3" X 30 LF  FEED OUT OF ROOM
```

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

#8

05/05/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10233
REVISION LETTER 'A'
SHEET 01 OF SHEET 01

GLENBROOK NORTH HIGH SCHOOL

>> KITCHEN <<

```
1 INCOMING FEED            IN<BK> =    9<   -3> PSIG              (1) 3/4 SG -B-06
  (1) --3/4 MH B   #11   TAG #132   DRIP - 3" X 150 LF

2 AIR HANDLER UNIT         IN<BK> =    9<   -3> PSIG              (1) 1.0 SG -B-13
  (1) 1-1/4 MH B   #8    TAG #133    PREHEAT COIL - MARLO COIL CO.  MODEL F-10  SERIAL #M65669  100%OA  DUCT COIL 18" X 5'9

3 AIR HANDLER UNIT         IN<BK> =    9<   -3> PSIG              (1) 1.0 SG -B-11
  (1) 1---- MH B   #12   TAG #134    REHEAT COIL - 2' X 4'  ALSO DUCT SIDE   COIL A1

4 KETTLE                   IN<BK> =    9<   -3> PSIG              (1) 1/2 SG -B-09
  (1) --1/2 -- -         TAG #135   KETTLE - GROEN MODEL D305P  30 GAL CAP. 24"DIA X 21"DEEP  GENERAL COOKING USE

5 KETTLE                   IN<BK> =    9<   -3> PSIG              (1) 1/2 SG -B-09
  (1) --1/2 -- -         TAG #136   KETTLE - GROEN 40 GAL CAP.  26"DIA X 22"DEEP  TO BOIL WATER ONLY

6 DISHWASHER               IN<BK> =    9<   -3> PSIG              (1) 3/4 SG -B-12
  (1) --3/4 -- -         TAG #137   HEX - HOBART MODEL FT-20  SERIAL #128609   6"DIA X 26"L
```

9

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/29/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER   - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10204
REVISION LETTER 'B'
SHEET 01 OF SHEET 04

GLENBROOK NORTH HIGH SCHOOL

```
 1 BY ENTRANCE 2N/3N     IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG # 93   UNIT VENT - 10" X 40" COIL   HERMAN NELSON     AREA D

 2 ABOVE LOCKER #H1      IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-08
   (1) --3/4 -- -      TAG # 94   CONVECTOR - 4" X 4" X 40 LF    AREA D

 3 ENGLISH CORR 2ND FL   IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-09
   (1) --3/4 -- -      TAG # 95   CONVECTOR - 4" X 4" X 60 LF  ALONG OUTSIDE WINDOW   AREA 6

 4 ENGLISH CORR 2ND FL   IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-09
   (1) --3/4 -- -      TAG # 96   CONVECTOR - 4" X 4" X 60 LF  ALONG OUTSIDE WINDOW    AREA 6

 5 ENGLISH RM 266        IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG # 97   CONVECTOR - 4" X 4" X 16 LF  ALONG OUTSIDE WINDOW    AREA 6

 6 ENGLISH ROOM 266      IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG # 98   UNIT VENT - TRANE #75   10" X 32" COIL    AREA 6

 7 ROOM A 264            IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG # 99   CONVECTOR - FIN/TUBE  4" X 4" X 16 LF   ROOM CONVECTORS 16" DOWN INSIDE WINDOW BOOKCASE

 8 ROOM A 262            IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG #100   UNIT VENT - TRANE SIZE 75   AREA 6

 9 ROOM A 260            IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG #101   CONVECTOR - 4" X 4" X 16 LF    AREA 6

10 ROOM A-260            IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG #102   UNIT VENT - SIZE 75    AREA 6

11 ROOM A 212            IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG #103   CONVECTOR - 4" X 4" X 16 LF    AREA 6

12 ROOM A 212            IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG #104   UNIT VENT - SIZE 75   AREA 6

13 ROOM A 214            IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG #105   CONVECTOR - 4" X 4" X 16 LF    AREA 6

14 ROOM A 214            IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG #106   UNIT VENT - SIZE 75    AREA 6

15 ROOM A 216            IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- -      TAG #107   CONVECTOR - 4" X 4" X 16 LF    AREA 6

16 ROOM A 216            IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-06
   (1) --3/4 -- -      TAG #108   UNIT VENT - SIZE 75    AREA 6
```

a 10

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/29/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10204
REVISION LETTER 'B'
SHEET 02 OF SHEET 04

GLENBROOK NORTH HIGH SCHOOL

```
17 ROOM A 220                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #109  CONVECTOR - 4" X 4" X 16 LF   AREA 6

18 ROOM A 220                 IN<BK> =    9<  -3> PSIG              (1) 3/4 SG -R-06
   (1) --3/4 -- -    TAG #110  UNIT VENT - SIZE 75   AREA 6

19 ROOM A 222                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #111  CONVECTOR - 4" X 4" X 16 LF   AREA 6

20 ROOM A 222                 IN<BK> =    9<  -3> PSIG              (1) 3/4 SG -R-06
   (1) --3/4 -- -    TAG #112  UNIT VENT - SIZE 75   AREA 6

21 ROOM A 226                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #113  CONVECTOR - 4" X 4" X 16 LF   AREA 6

22 ROOM A 226                 IN<BK> =    9<  -3> PSIG              (1) 3/4 SG -R-06
   (1) --3/4 -- -    TAG #114  UNIT VENT - SIZE 75   AREA 6

23 ROOM A 230                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #115  CONVECTOR - 4" X 4" X 16 LF   AREA 6

24 ROOM A 230                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-06
   (1) --1/2 -- -    TAG #116  UNIT VENT - SIZE 75   AREA 6

25 ROOM A 234                 IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #117  CONVECTOR - 4" X 4" X 16 LF   AREA 6

26 ROOM A 234                 IN<BK> =    9<  -3> PSIG              (1) 3/4 SG -R-06
   (1) --3/4 -- -    TAG #118  UNIT VENT - SIZE 75   AREA 6

27 STUDENT ACT HALL           IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-06
   (1) --1/2 -- -    TAG #119  CONVECTOR - 4" X 4" X 20 LF   AREA 6

28 STUDENT ACT HALL           IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-06
   (1) --1/2 -- -    TAG #120  CONVECTOR - 4" X 4" X 20 LF   AREA 6

29 STUDENT ACT HALL           IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-08
   (1) --1/2 -- -    TAG #121  CONVECTOR - 4" X 4" X 40 LF   AREA 6

30 STUDENT ACT HALL           IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-08
   (1) --1/2 -- -    TAG #122  CONVECTOR - 4" X 4" X 36 LF   AREA 6

31 STUDENT ACT HALL           IN<BK> =    9<  -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- -    TAG #123  CONVECTOR - 4" X 4" X 18 LF   AREA 6

32 OUTSIDE HEALTH OFC         IN<BK> =    9<  -3> PSIG              (1) 3/4 SG -R-06
   (1) --3/4 -- -    TAG #124  UNIT VENT - 10" X 30" COIL   AREA 6
```

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/29/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10204
REVISION LETTER 'B'
SHEET 03 OF SHEET 04

GLENBROOK NORTH HIGH SCHOOL

```
33 CONVECTOR                 IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-06
   (1) --3/4 -- -        TAG #125   CONVECTOR - 4" X 4" X 20 LF  NOTE - NO SOLONOID   H AREA TUNNEL

34 OUTSIDE YOUTH OFFICE      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-06
   (1) --3/4 -- -        TAG #126   UNIT VENT - 10" X 34" COIL   HERMAN NELSON    AREA G

35 BY DOOR 102 SN            IN<BK> =    9<  -3> PSIG        (NOT APPLICABLE)
   (1) --1/2 -- -        TAG #127   UNIT VENT - MODINE   HOT WATER.......NO TRAP    AREA G

36 BY DOOR 108 SM            IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-08
   (1) --3/4 -- -        TAG #128   CONVECTOR - 4" X 4" X 40 LF    AREA C

37 BY DOOR 82P               IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-08
   (1) --1/2 -- -        TAG #129   CONVECTOR - 4" X 4" X 40 LF    AREA C

38 CAFETERIA ROOM C 420      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-10
   (1) --3/4 -- -        TAG #130   CONVECTOR - 4" X 4" X 72 LF TOTAL  DOUBLE TIER ASSEMBLY    AREA C

39 CAFETERIA ROOM C 420      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-10
   (1) --3/4 -- -        TAG #131   CONVECTOR - 4" X 4" X 72 LF TOTAL- DOUBLE TIER ASSEMBLY    AREA C

40 CORRIDOR/TRAIN. RM        IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- -        TAG # 81   CONVECTOR - FIN/TUBE   4" X 4" X 5 LF  NOT NORMALLY ON.    AREA E

41 BOY'S LOCKER ROOM         IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-07
   (1) 1---- -- -        TAG # 82   AHU - 4'6" X 6" COIL  VERTICAL AIR FLOW  100% RECIRC   HERMAN NELSON   AREA E

42 LOCKER RM FOR TRAING      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-07
   (1) 1-1/4 -- -        TAG # 83   UNIT VENT - HAF  AT CEILING   100% RECIRC   COIL APPROX 6" X 6 LF    AREA E

43 LOCKER RM FOR TRAING      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-07
   (1) 1-1/4 -- -        TAG # 84   UNIT VENT - HAF  AT CEILING   100% RECIRC   COIL APPROX 6" X 6 LF   AREA E

44 CORRIDOR MEN'S TR RM      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-06
   (1) --3/4 -- -        TAG # 85   UNIT VENT - 9" X 26" COIL   MODINE    AREA E

45 CORRIDOR DOOR 62 W        IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-06
   (1) --3/4 -- -        TAG # 86   UNIT VENT - 10" X 38" COIL   MODINE    AREA D

46 GYM ENTRANCE BY D532      IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-06
   NO TRAP.......(NONE)  TAG # 87   UNIT VENT - COIL  5" X 1-1/2" X 44"   MODINE

47 GYMNASTICS RM D562        IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-06
   (1) --1/2 -- -        TAG # 88   CONVECTOR - FIN/TUBE  4" X 4" X 27 LF

48 GYMNASTICS RM D562        IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-06
   (1) --1/2 -- -        TAG # 89   CONVECTOR - FIN/TUBE  4" X 4" X 27 LF
```

12

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/29/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10204
REVISION LETTER 'B'
SHEET 04 OF SHEET 04

GLENBROOK NORTH HIGH SCHOOL

49 GYMNASTICS RM D562 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- - TAG # 90 CONVECTOR - FIN/TUBE 4" X 4" X 27 LF

50 GYMNASTICS RM D562 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- - TAG # 91 CONVECTOR - FIN/TUBE 4" X 4" X 27 LF

51 ENTRANCE ACROSS D536 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- - TAG # 92 CONVECTOR - FIN TUBE 5" X 1'2" X 44"

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

13

03/31/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10434
REVISION LETTER 'B'
SHEET 01 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> AREA B - OLD SCIENCE <<

1 PRE-SCHOOL STORAGE IN<BK> = 9< -3> PSIG (NOT APPLICABLE)
(1) --1/2 -- D CONVECTOR - 4 X 4 X 5 LF NOT USED

2 MEN'S ROOM IN<BK> = 9< -3> PSIG (NOT APPLICABLE)
(1) --1/2 -- D CONVECTOR - 4 X 4 X 5 LF NOT WANTED. SHUT-OFF THE VALVE

3 B-330 CHEM WORKSHOP IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-11
(1) --3/4 -- - AHU - COIL 32 X 30 APPROX 33% O.A. ABOVE FALSE CEILING (PRV)

4 B-330 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-06
(1) --3/4 -- - CONVECTOR - 4 X 4 X 21 LF (PRV)

5 B-330 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - (FAN) TRANE #75 2" X 10" X 31" COIL 750 CFM 33% O.A. (SOL)

6 STOR B-330/332 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF LEAK. (PRV)

7 B-334 E IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 21 LF (PRV)

8 B-334 E IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - TRANE 33% O.A. 750 CFM (SOL)

9 B-336 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 21 LF (PRV)

10 B-336 IN<BK> = 9< -3> PSIG (3) 3/4 SG -B-08
(1) --3/4 -- D UNIT VENT - TRANE #75 750 CFM 33% O.A. (SOL)

11 ACROSS FROM B-342 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - MODINE COIL 1-1/2 X 8 X 33 ASSUME 900 CFM BY DOOR 865 C (SOL)

12 GREENHOUSE OFFICE IN<BK> = 9< -3> PSIG (NOT APPLICABLE)
(1) --3/4 -- D ELIMINATED.......UNIT REMOVED

13 GREENHOUSE OFFICE IN<BK> = 9< -3> PSIG (NOT APPLICABLE)
(1) --3/4 -- - ELIMINATED.......UNIT REMOVED

14 GREENHOUSE B-342 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- - CONVECTOR - 4 X 4 X 40 LF AT WINDOW

15 B-350 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 20 LF + 1-1/2 X 10 LF BARE PIPE (PRV)

16 B-350 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-09
(1) --3/4 -- D UNIT VENT - TRANE 125 33% O.A. ASSUME 1250 CFM (SOL)

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

14

03/31/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10434
REVISION LETTER 'B'
SHEET 02 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

17 B-350 WORKROOM IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 10 LF STYLE CS VULCAN

18 B-354 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 12 LF + 1-1/2 X 10 LF BARE (PRV)

19 B-354 IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-09
(1) --3/4 -- D UNIT VENT - TRANE 125 33% O.A.. 1250 CFM (SOL)

20 B-356 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 10 LF (PRV)

21 B-356 IN<BK> = 9< -3> PSIG (3) 3/4 SG -R-09
(1) --3/4 -- D UNIT VENT - TRANE 125 33% O.A. ASSUMED (SOL)

22 B-356 WORKSHOP IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 10 LF STYLE CS VULCAN

23 B-358 CHEMISTRY IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 16 LF (PRV)

24 B-358 IN<BK> = 9< -3> PSIG (4) 3/4 SG -R-09
(1) --3/4 -- D UNIT VENT - COIL 2 X 12 X 46 TRANE A-125 SN U796 33% O.A. ASSUME 1250 CFM (SOL)

25 SCIENCE HALL IN<BK> = 9< -3> PSIG (3) 1/2 SG -R-07
(1) --1/2 -- D CONVECTOR - 4 X 4 X 30 LF OVER LOCKERS (3) UNITS (PRV)

26 B-358 TUNNEL IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-06
(1) --3/4 -- D TAG #183 CONVECTOR - 4 X 4 X 20 LF TRAP IN TUNNEL BELOW (PRV)

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

15

03/31/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10434
REVISION LETTER 'B'
SHEET 03 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> AREA B - TUNNEL <<

```
27 BENEATH B-346            IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-05
   (1) --3/4 -- -     TAG #178   DRIP - 2" X 20 LF + 4" X 30 LF   END OF LINE

28 BENEATH LOCKERS          IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-09
   (1) --3/4 -- -     TAG #179   DRIP - 4" X 15 LF + 6" X 250 LF   END OF MAIN   BAD TRAP

29 BENEATH LOCKERS          IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- D     TAG #180   DRIP - 2" X 15 LF VERT. FEED TO LOCKERS   BAD TRAP

30 BENEATH END OF HALL      IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-06
   (1) --3/4 -- -     TAG #181   DRIP - 2" X 180 LF   END OF LINE   BAD TRAP

31 BENEATH SCIENCE          IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-06
   (1) --3/4 -- -     TAG #182   DRIP - 2" X 180 LF   BAD TRAP

32 BENEATH LOCKER           IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- D     TAG #184   DRIP - 2" X 15 LF VERT FEED TO LOCKER   BAD TRAP

33 BENEATH WOODSHOP         IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-09
   (1) --3/4 -- -     TAG #185   DRIP - 6" X 300 LF EST.   BAD TRAP

34 BENEATH B-346            IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -R-05
   (1) --3/4 -- D                DRIP - 2" X 40 LF
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ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

16

03/31/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER   - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10434
REVISION LETTER 'B'
SHEET 04 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

>> AREA B - INDUSTRIAL ARTS <<

```
35 B-346 SMALL ENG.          IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -R-07
   (1) --3/4 -- D             UNIT VENT - MODINE COIL  1-1/2 X 8 X 32  ASSUME 670 CFM  100% RECIRC.  (SOL)

36 METAL SHOP CLASSROOM      IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 15 LF   (PRV)

37 METAL SHOP CLASSROOM      IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -R-07
   (1) --3/4 -- D             UNIT VENT - TRANE #75   100% O.A.   2" X 12" X 30"   500 CFM   (SOL)

38 METAL SHOP B-344          IN<BK> =     9<   -3> PSIG              (1) 1.0 SG -B-05
   (1) 1-1/4 -- -       TAG #187   DRIP - 3" X 20 LF   AFTER PRV   (PRV)

39 ROOM B-344                IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-15
   (1) --3/4 -- -       TAG #188   AHU - 7500 CFM  TRANE COIL APPROX 2 LF X 8 LF   APPROX 60% O.A.   (PRV)

40 ROOM B-344                IN<BK> =     9<   -3> PSIG              (1) 1.0 SG -B-00
   (1) 1---- -- -       TAG #189   AHU - +1-1/2 X 20 LF DRIP  AAF #S2  COIL 24 X 40   SPECS REQUIRED   (PRV)

41 HALL BY B-346             IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -R-07
   (1) --3/4 -- D             UNIT VENT - NELSON  COIL - 1-1/2 X 8 X 37 (LEAKING)  ASSUME 1545 CFM  I.A.   (SOL)

42 B-340 AU TO SHOP          IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-10
   (1) --3/4 -- -             HORIZ UH - MODINE  HS720  24 X 24 COIL   COOL AREA   (2) UNITS

43 B-340 STORAGE             IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-05
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 8 LF   (PRV)

44 B-340 OFFICE              IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-06
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 20 LF AT WINDOW/CEILING   (PRV)

45 WOOD SHOP                 IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-06
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 20 LF AT WINDOW/CEILING   (PRV)

46 WOOD SHOP                 IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-06
   (1) --3/4 -- -             HORIZ UH - TRANE  15 X 17

47 B-336 PAINT STORAGE       IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -B-05
   (1) --1/2 -- -             CONVECTOR - 4 X 4 X 15 LF   STYLE CS VULCAN   (PRV)

48 B-336                     IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -R-09
   (1) --3/4 -- D             CONVECTOR - 4 X 4 X 40 LF   STYLE CS.   (PRV)

49 B-336                     IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-00
   (1) --3/4 -- -             DRIP - 4" X 200 LF APPROX   END OF MAIN FEED   FEED TO AHU   GOOD TRAP

50 B-336                     IN<BK> =     9<   -3> PSIG              (1) 1.0 SG -B-00
   (1) 1---- -- -             AHU - COIL APPROX 2 LF X 6 LF  1/3 2/3 CONTROL   SPECS REQUIRED   APPROX 60% O.A. (PRV)
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ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

17

03/31/83

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10434
REVISION LETTER 'B'
SHEET 05 OF SHEET 05

GLENBROOK NORTH HIGH SCHOOL

51 B-332 CLASSROOM IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-00
(1) --3/4 -- - AHU (#S-1) - SPECS REQUIRED CHECK STEAM TO TRAP TO VACUUM PIPING (PRV)

52 B-332 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 15 LF (PRV)

53 B-332 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - TRANE #75 33% O.A. 750 CFM (SOL)

54 B-328 DRAFTING IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - TRANE #75 33% O.A. 1000 CFM (2) UNITS (SOL)

55 B-328 NORTH IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-09
(1) --3/4 -- D CONVECTOR - 4 X 4 X 40 LF (PRV)

56 B-328 WEST IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D CONVECTOR - 4 X 4 X 30 LF (PRV)

57 B-328 DRAFTING IN<BK> = 9< -3> PSIG (1) 1.0 SG -B-00
(1) 1---- -- - AHU - S-3 SPECS REQUIRED (PRV)

18

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10429
REVISION LETTER 'A'
SHEET 01 OF SHEET 01

GLENBROOK NORTH HIGH SCHOOL

>> AREA B <<

```
1 LITTLE THEATER          IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-09
  (1) --3/4 -- -        TAG #169   DRIP - 2-1/2" X 250 LF EST. UNINSULATED  FEED TO C-424 STUDY HALL.

2 HALL BY ROOM B-322      IN<BK> =   9<  -3> PSIG            (1) 1/2 SG -R-08
  (1) --1/2 MH D                   UNIT VENT - (FAN)  COIL 3" X 9" X 50"LG  1500 CFM EST.   (SOL)

3 BY WINDOW               IN<BK> =   9<  -3> PSIG            (2) 1/2 SG -R-05
  (2) --1/2 MH D                   CONVECTOR - 4" X 4" X 66"  (NO FAN)  NO SOLENOID.  (2) WINDOW UNITS

4 FACULTY CAFETERIA       IN<BK> =   9<  -3> PSIG            (2) 1/2 SG -R-05
  (1) --1/2 MH D                   CONVECTOR - (NO FAN)  4" X 4" X 66"  (2) WINDOW UNITS  (SOL)
```

19

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10430
REVISION LETTER 'A'
SHEET 01 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA C <<

1 HALL SHOWCASE IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-06
(2) --3/4 -- D UNIT VENT - (FAN) 1-1/2" X 8 X 42"LG SEE ALSO TAG #128 (2) UNITS (SOL)

2 C-416 IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-00
(1) --3/4 -- - AHU - SPECS REQUIRED. KITCHEN OF HOME ECONOMICS (PRV)

3 C-416 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - (NO FAN) 4 X 4 X 12 LF (SOL)

4 C-410 DEMO ROOM IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-09
(1) --3/4 -- D UNIT VENT - (FAN) 1560 CFM 100%O.A. TRANE SIZE 75 (SOL)

5 C-408 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - (NO FAN) 4 X 4 X 18 LF COMES FROM C-410 (SOL)

6 C-408 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - (FAN) 10" X 30" X 3" 1000 CFM APPROX TRANE SIZE 75 (SOL)

7 HALL DOOR 80-P IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-06
(1) --3/4 -- D UNIT VENT - (FAN) 1-1/2 X 9 X 4 LF EST. 1000 CFM MODINE (SOL)

8 DOOR 12-N IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D UNIT VENT - (FAN) 4 X 8 X 29" 315 CFM TRANE 100-2. SN F007. (SOL)

9 DOOR 79-P IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - (FAN) 3 X 8 X 3 LF COIL MODINE EST. 1500 CFM CLASS ROOM C-400 (SOL)

10 C-400 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - (FAN) 12" X 46" X 3" 1560 CFM 100%O.A. TRANE A125 SN U782. (SOL)

11 C-402 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D CONVECTOR - 4 X 4 X 25 LF FROM C-400 (SOL)

12 C-402 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-06
(1) --3/4 -- D CONVECTOR - 4 X 4 X 18 LF (SOL)

13 C-402 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-08
(1) --1/2 -- D UNIT VENT - (FAN) TRANE A125 1560 CFM 100%O.A. (SOL)

14 C-406 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (SOL)

15 C-406 IN<BK> = 9< -3> PSIG (2) 1/2 SG -R-05
(2) --1/2 -- D CONVECTOR - 4 X 4 X 12 LF (2) UNITS (SOL)

16 C-406 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

20/

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10430
REVISION LETTER 'A'
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

17 CLAY ROOM C-406 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-0
(1) --1/2 -- D CONVECTOR - 4 X 4 X 20 LF (SOL)

18 CLAY ROOM C-406 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-0
(1) --1/2 -- D CONVECTOR - 4 X 4 X 9 LF (SOL)

19 CLAY ROOM C-406 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-0
(1) --3/4 -- D UNIT VENT - (FAN) TRANE A125 1560 CFM 100% O.A. (SOL)

20 CLAY ROOM C-406 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-0
(1) --1/2 -- D CONVECTOR - 4 X 4 X 26 LF (SOL)

CONVECTOR 25'
55'

1/2 REV 0.
1/2 REV 0.

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

21

11/30/82

SURVEY / APPLICATIONS SCHEDULE

PROPOSAL #10435
REVISION LETTER 'A'
SHEET 01 OF SHEET 02

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

GLENBROOK NORTH HIGH SCHOOL

>> AREA C - TUNNEL <<

```
 1 ART TUNNEL             IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #172   DRIP - 1-1/2" X 70 LF APPROX TO VERTICAL FEED    END OF FEED.

 2 TUNNEL UNDER CLAY      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #173   DRIP - 3" X 100 LF + 1-1/2 X 50 LF   VERT FEEDS   END OF LINE   BAD TRAP

 3 N END OF E TUNNEL      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #174   DRIP - 2"X100LF + 3"X40LF + 4"X80LF + 1-1/2"X50LF VERT FDS. END OF MAIN FEED TO ART.

 4 UNDER ROOM C-410       IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #175   DRIP - 2" X 80 LF EST.   END OF LINE   BAD TRAP

 5 FEED TO DOOR 12-N      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #176   DRIP - 2" X 20 LF   END OF LINE

 6 SCIENCE                IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-0
   (1) --3/4 -- -       TAG #177   DRIP - 2"X30 LF + 6"X130LF FEED FROM CHOCK GENERATOR TAG#70 END OF MAIN TO AREA BD TRAP
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ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

22

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10435
REVISION LETTER 'A'
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA C <<

7 BY C-424 IN HALL IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - 1-1/2 X 8 X 3 LF 500 CFM (SOL)

8 LAUNDRY ROOM IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-0
(1) --3/4 -- - HEATER - UNIT NOT SEEN

9 C-422 IN<BK> = 9< -3> PSIG (1) 1.0 SG -B-0
(1) 1---- -- D AHU - H NELSON ASSUME 50% O.A. 1250 CFM (PRV)

23

ENGINEERING RESOURCES, INC.

CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10436
REVISION LETTER 'A'
SHEET 01 OF SHEET 03

GLENBROOK NORTH HIGH SCHOOL

>> AREA D - TUNNEL <<

1 NW UNDER SUPPLY IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-05
(1) --3/4 -- - TAG #190 DRIP - 3" X 30 LF VERTICAL FEED TO KITCHEN AHU

2 UNDER CAF. C-424 IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-0
(1) --3/4 -- - TAG #191 DRIP - 3" X 125 LF + 2" X 100 LF END OF LINE BAD TRAP

3 UNDER LAUNDRY IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-0
(1) --3/4 HN F TAG #192 DRIP - 4" X 130 LF EST.

4 UNDER LAUNDRY IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-0
(1) --3/4 -- - TAG #193 DRIP - 2" X 130 LF EST. BAD TRAP

5 UNDER GIRL'S LOCKER IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-05
(1) --3/4 -- - TAG #194 DRIP - 2-1/2 X 30 LF VERTICAL FEED TO UNIT HEATER

6 UNDER GIRL'S LOCKER IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-
(1) --3/4 -- - TAG #195 DRIP - 3" X 10 LF + 2" X 100 LF CHECK BAD TRAP UPSTAIRS END OF FEED BAD TRAP

7 PE HALL IN<BK> = 9< -3> PSIG (1) 3/4 SG -B-0
(1) --3/4 -- - TAG #196 DRIP - 4" X 60 LF BY TAG #78 VERTICAL FEED

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

24

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10436
REVISION LETTER 'A'
SHEET 02 OF SHEET 03

GLENBROOK NORTH HIGH SCHOOL

>> AREA D <<

```
 8 CONCESSION STAND        IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-05
   (1) --3/4 -- -           DRIP - 2" X 60 LF EST

 9 HALL STUD. ACT CLST     IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -R-07
   (1) --3/4 -- D           UNIT VENT - 100% RECIRC COIL APPROX 1-1/2 X 10 X 48 + DRIP  2" X 30 LF  500 CFM   (SOL)

10 HALL STUD. ACT CLST     IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-07
   (1) --1/2 -- D           UNIT VENT - 1-1/2 X 8 X 44 APPROX   100% RECIRC  500 CFM  OPPOSIT ABOVE UNIT   (SOL)

11 COACHES LOCKER ROOM     IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -R-07
   (1) 1-1/4 -- -           UNIT VENT - VAF  COIL 6" X 4'6"  100% RECIRC.   500 CFM AT CEILING   (SOL)

12 SHOWER STALL/C.LKR      IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-05
   (1) --1/2 -- D           CONVECTOR - 4 X 4 X 16 LF  ON WALL/HIGH   (PRV)

13 NEAR C. LKR. ENTR.      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -R-08
   (1) --3/4 -- D           UNIT VENT - 1-1/2 X 8 X 4 LF COIL  EST. 100% RECIRC  500 CFM  MODINE   (SOL)

14 P.E. LOCKER ROOM        IN<BK> =    9<  -3> PSIG               (2) 1.0 SG -B-08
   (1) 1---- -- -           UNIT VENT - VAF  1000 CFM   100% O.A.   H. NELSON AT CEILING  (2) UNITS   (SOL)

15 BOY'S EQUIPMENT ROOM    IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-07
   (1) --3/4 -- -       TAG #204    UNIT VENT - VAF 500 CFM   100% RECIRC AT CEILING COIL EST 1-1/2 X 8 X 3 LF   (SOL)

16 SOUTH LOBBY STAIRWAY    IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -R-07
   (1) --3/4 -- -           UNIT VENT - 1-1/2 X 8 X 3 LF  100% RECIRC. 500 CFM MODINE  BY D-556.   (SOL)

17 CATWALK OVER M GYM      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-08
   (1) --3/4 -- -           HORIZ UH - 24 X 24  MODINE H455L

18 CATWALK OVER M GYM      IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-05
   (1) --1/2 -- D           DRIP - 2" X 50 LF  END OF LINE TO UNIT HEATER

19 BEAM OVER LOBBY CTWK    IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-05
   (1) --1/2 -- D           DRIP - 2" X 30 LF   FEED TO ABOVE UNIT HEATER

20 N OF LOBBY CATWALK      IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -B-08
   (1) --3/4 -- -           HORIZ UH - 24 X 24  MODINE

21 D-556 DANCE ROOM        IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-08
   (1) --1/2 -- D           CONVECTOR - 4 X 4 X 36 LF    (PRV)

22 D-556                   IN<BK> =    9<  -3> PSIG               (1) 3/4 SG -R-08
   (1) --3/4 -- D           CONVECTOR - 4 X 4 X 36 LF    (PRV)

23 ATH PE SEC              IN<BK> =    9<  -3> PSIG               (1) 1/2 SG -R-09
```

ENGINEERING RESOURCES, INC. 25
CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10436
REVISION LETTER 'A'
SHEET 03 OF SHEET 03

GLENBROOK NORTH HIGH SCHOOL

24 COORDS OFFICE IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D DRIP - 1-1/2 X 50 LF BARE EST. END OF FEED FROM UPSTAIRS FAN ROOM

25 BOY'S PE IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 15 LF MANUAL SHUT OFF

26 ASST. ATH DIR OFFICE IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 18 LF MANUAL SHUT OFF

27 GIRL'S SHELF IN<BK> = 9< -3> PSIG (3) 1/2 SG -R-07
(1) --1/2 -- D CONVECTOR - 4 X 4 X 27 LF HIGH SEE TAG 88-91. ADD (3) UNITS (PRV)

28 BOY'S SHELF IN<BK> = 9< -3> PSIG (3) 1/2 SG -R-0
(1) --1/2 -- D CONVECTOR - 4 X 4 X 27 LF HIGH/WALL/WINDOW SEE TAG 88-91 ADD (3) UNITS (PRV)

29 SHELF STORE ROOMS IN<BK> = 9< -3> PSIG (2) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 10 LF MANUAL VALVE (2) UNITS

30 D-550 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 20 LF FOR BOY'S GYMNASTIC OFFICE (PRV)

31 D-550 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D CONVECTOR - 4 X 4 X 20 LF (PRV)

32 NORTH LAUNDRY DOOR IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - 1-1/2 X 8 X 3 LF 100% RECIRC. 500 CFM (SOL)

33 OUTSIDE HALL DOOR 5N IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - 1-1/2 X 10 X 4 LF 100% RECIRC. 760 CFM (SOL)

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

26

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10437
REVISION LETTER 'A'
SHEET 01 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA E - TUNNEL <<

1 UNDER BOY'S LOCKER   IN<BK> = 9< -3> PSIG   (1) 3/4 SG -B-07
(1) --3/4 -- -   TAG #197   DRIP - 4" X 60 LF + 3" X 80 LF

2 UNDER MUSIC   IN<BK> = 9< -3> PSIG   (1) 1.0 SG -B-06
(1) 1---- -- -   TAG #198   DRIP - 3" X 80 LF   END OF FEED

3 MUSIC FEED   IN<BK> = 9< -3> PSIG   (1) 3/4 SG -B-05
(1) --3/4 -- -   TAG #199   DRIP - 1-1/2 X 40 LF EST   VERT. FEED   AFTER SOL   (SOL)

4 END OF MUSIC HALL   IN<BK> = 9< -3> PSIG   (1) 3/4 SG -B-05
(1) --3/4 -- -   TAG #200   DRIP - 1-1/4 X 20 LF BARE   SEE BAD TRAP #6   AFTER SOL.   NEAR CPA FAN ROOM   (SOL)

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10437
REVISION LETTER 'A'
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA E <<

```
 5 MUSIC HALL                IN<BK> =     9<   -3> PSIG              (5) 1/2 SG -R-0
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 25 LF   (5 UNITS)   (PRV)

 6 BOY'S ROOM                IN<BK> =     9<   -3> PSIG              (1) 1/2 SG -R-0
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 3 LF    (PRV)

 7 E-606                     IN<BK> =     9<   -3> PSIG       (NOT APPLICABLE)
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 21 LF    (PRV)

 8 E-608                     IN<BK> =     9<   -3> PSIG       (NOT APPLICABLE)
   (1) --1/2 -- D             CONVECTOR - 4 X 4 X 21 LF    (PRV)

 9 E-618                     IN<BK> =     9<   -3> PSIG              (1) 3/4 SG -B-0
   (1) --3/4 -- -     TAG #201   DRIP - 4" X 40 LF   FEED TO ROOM/HEX

10 FOR SU-8                  IN<BK> =     9<   -3> PSIG              (1) 1.0 SGL-B-2
   (1) 1-1/2 -- -     TAG #202   HEX - 10"DIA X 91"LG (P-K)  COILS AT MAX 150 F    AHU 13835 CFM

11 BY STAIRS                 IN<BK> =     9<   -3>.PSIG              (1) 3/4 SG -B-0
   (1) --3/4.-- -     TAG #203   HORIZ UH - 12 X 12   H. NELSON #SU1221A
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ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

28

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10431
REVISION LETTER 'A'
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

```
17 ROOM F-712           IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

18 STORAGE F-708        IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - (FAN) 33%O.A. 750 CFM EST. TOTAL HTG EDR 191 HN-RJC63421-3 (SOL)

19 F-708                IN<BK> =    9<  -3> PSIG          (2) 1/2 SG -R-05
   (2) --1/2 -- D        CONVECTOR - 4 X 4 X 6 LF (2) UNITS (SOL)

20 F-708                IN<BK> =    9<  -3> PSIG          (2) 3/4 SG -R-07
   (2) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

21 F-708 TYPING OFF     IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 6 LF (SOL)

22 F-708 TYPING OFF     IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

23 F-700                IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 6 LF (SOL)

24 F-700                IN<BK> =    9<  -3> PSIG          (2) 3/4 SG -R-07
   (2) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

25 F-704                IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 6 LF (SOL)

26 F-704                IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

27 F-704                IN<BK> =    9<  -3> PSIG          (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 6 LF (SOL)

28 F-704                IN<BK> =    9<  -3> PSIG          (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)
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ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

29

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10431
REVISION LETTER 'A'
SHEET 01 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA F <<

1 DOOR 152-GM IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-07
(1) --1/2 -- D UNIT VENT - (FAN) COIL 1-1/2 X 8 X 48 1500 CFM EST. FACE DIM 20 X 57. (SOL)

2 BOY'S WASHROOM IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-06
(1) --1/2 -- D UNIT VENT - (FAN) 1-1/2 X 8 36 TRANE FULL LOUVER COVER 28 X 42. (SOL)

3 ENTRANCE - 425 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - (FAN) 2 X 10 X 48 WDZF-2431 452 EDR 1383 CFM H NELSON CASE 60X34 (SOL)

4 LADIES IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 10 LF (SOL)

5 CPA ENTRANCE IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-08
(1) --3/4 -- D UNIT VENT - (FAN) 1-1/2 X 8 X 5 LF HN ABOUT 450 EDR FIRE ALARM 59. (SOL)

6 ROOM F-722 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (SOL)

7 ROOM F-722 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

8 ROOM F-718 IN<BK> = 9< -3> PSIG (2) 1/2 SG -R-05
(2) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (2) UNITS (SOL)

9 ROOM F-718 IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-07
(2) --3/4 -- D UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

10 ROOM F-720 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (SOL)

11 ROOM F-720 IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-07
(2) --3/4 -- D UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

12 ROOM F-716 IN<BK> = 9< -3> PSIG (2) 1/2 SG -R-05
(2) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (2) UNITS (SOL)

13 ROOM F-716 IN<BK> = 9< -3> PSIG (1) 3/4 SG -R-07
(1) --3/4 -- D UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

14 ROOM F-714 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (SOL)

15 ROOM F-714 IN<BK> = 9< -3> PSIG (2) 3/4 SG -R-07
(2) --3/4 -- D UNIT VENT - FAN HN 750 CFM 191 EDR -10F ADESGN 2 PSI RATING START 35%OA THESE (SOL)

16 ROOM F-712 IN<BK> = 9< -3> PSIG (1) 1/2 SG -R-05
(1) --1/2 -- D CONVECTOR - 4 X 4 X 6 LF (SOL)

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

30/

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10432
REVISION LETTER 'A'
SHEET 01 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA 6 <<

```
 1 STUDENT ACT OFFICE   IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 MH D        CONVECTOR - 4" X,4" X 60"L6 FINS   (SOL)

 2 HALL BY G-18         IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-07
   (1) --3/4 MH D        UNIT VENT - (FAN)  3 X 8 X 22   1000 CFM EST.   (SOL)

 3 GUIDANCE OFFICES     IN<BK> =    9<  -3> PSIG            (4) 1/2 SG -R-05
   (4) --1/2 -- D        CONVECTOR - FIN 4 X 4 X 72"  BY WINDOW  (4) UNITS   (SOL)

 4 H-AREA TUNNEL        IN<BK> =    9<  -3> PSIG      (NOT APPLICABLE)
   (1) --3/4 MH D  2-4   TAG #125  CONVECTOR - 4 X 4 X 20 LF  SEE PROPOSAL #10204   (SOL)

 5 GUIDANCE OFFICE      IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -B-0
   (1) --3/4 -- -        TAG #170  AHU - COIL 12" X 42" X 2"W  100%O.A.  AHU-C IN CEILING  SPECS REQUIRED   (PRV)

 6 GUIDANCE G-2         IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4" X 4" X 12 LF   (SOL)

 7 NURSES               IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 12 LF   (SOL)

 8 NURSES BED-S         IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 15 LF   (SOL)

 9 NURSES BED-N         IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D        CONVECTOR - 4 X 4 X 5 LF   (SOL)

10 HALL/HEALTH OFFICE   IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-07
   (1) --3/4 -- D        UNIT VENT - (FAN)  2 X 8 X 30"  1000 CFM EST.  BY FIRE ALARM #29   (SOL)

11 ABOVE CARPEN SHOP    IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-0
   (1) --1/2 -- D        TAG #171  CONVECTOR - 4 X 4 X 30 LF EST.  UNDER SEAT IN HALL   (SOL)

12 UNDER ST ACT STRWY   IN<BK> =    9<  -3> PSIG      (NOT APPLICABLE)
   (1) --3/4 MH D        AHU - COIL 12" X 3 LF  100% RECIRC.  NO REQUIRED - TO BE SHUT OFF.  (NO SOL)
```

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

31

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10432
REVISION LETTER 'A'
SHEET 02 OF SHEET 02

GLENBROOK NORTH HIGH SCHOOL

>> AREA G - FIRST FLOOR <<

```
13 HEWITT OFFICE          IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 8 LF   (SOL)

14 HEWITT OFFICE          IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 12 LF   (SOL)

15 PUBLIC ADDRESS         IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 5 LF   (SOL)

16 COMPUTER OFFICE        IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 5 LF   (SOL)

17 MAIL ROOM              IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 6 LF   (SOL)

18 M.O. SWITCHBOARD       IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 8 LF   (SOL)

19 SECURITY OFFICE        IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 11 LF   (SOL)

20 ASSOC. PRINCIPAL       IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- D          CONVECTOR - 4 X 4 X 10 LF   (SOL)

21 ASSOC. PRINCIPAL       IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-0
   (1) --3/4 -- D          UNIT VENT - (FAN)  1000 CFM  100% O.A.   3" X 10" X 31"   TRANE #75   (SOL)

22 PRINCIPAL              IN<BK> =    9<  -3> PSIG            (1) 1/2 SG -R-05
   (1) --1/2 -- -          CONVECTOR - 4 X 4 X 8 LF   (SOL)

23 CONFERENCE RUN         IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-06
   (1) --3/4 -- D          CONVECTOR - 4 X 4 X 18 LF   (SOL)

24 CONFERENCE             IN<BK> =    9<  -3> PSIG            (1) 3/4 SG -R-08
   (1) --3/4 -- D          UNIT VENT - TRANE 75   COIL 3 X 10 X 31"  1000 CFM  100% O.A.   2 ROW   (SOL)
```

ENGINEERING RESOURCES, INC.
CHICAGO, ILLINOIS

32

11/30/82

SURVEY / APPLICATIONS SCHEDULE

SALES ENGINEER - R. BARANSKI
APPLICATIONS ENGR - M. TROY

PROPOSAL #10433
REVISION LETTER "A"
SHEET 01 OF SHEET 01

GLENBROOK NORTH HIGH SCHOOL

>> AREA H GENERAL - BASEMENT <<

```
 1 ELEC MAINT SHOP        IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #160   DRIP - 3" X 40 LF  FEED TO TUNNEL

 2 BENEATH OVERHEAD DR    IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #161   DRIP - 2-1/2 X 150 LF  END OF LINE  BY VALVE #10

 3 TUNNEL CORNER          IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #162   DRIP - 2-1/2 X 150 LF  END OF LINE FROM CARP. SHOP

 4 TO AREA G              IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-00
   (1) --3/4 -- -      TAG #163   AHU - SEE G AREA GUIDANCE TAG #125  NEAR VALVES #11/12  (PRV)

 5 CARPENTER SHOP         IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #164   DRIP - 3" X 100 LF EST.  FEED TO TAG #160/AREA H

 6 CARPENTER SHOP         IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #165   DRIP - 3" X 30 LF + 2" X 110 LF

 7 CARPENTER SHOP         IN<BK> =   9<  -3> PSIG      (NOT APPLICABLE)
   (1) --1/2 -- -                 CONVECTOR - FINS 6" X 6" X 8 LF  TO BE REMOVED  NOT REQUIRED

 8 ELECTRIC SHOP          IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-05
   (1) --3/4 -- -      TAG #166   DRIP - 2-1/2 X 40 LF  FEED TO AHU

 9 EQUIPMENT 136          IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-00
   (1) --3/4 -- -      TAG #167   AHU - PREHEAT  DUCT 24 X 42  ASSUME 50% O.A.  FEEDS H AREA/OLD GUIDANCE  (PRV)

10 EQUIPMENT 136          IN<BK> =   9<  -3> PSIG            (1) 3/4 SG -B-00
   (1) --3/4 -- -      TAG #168   AHU - REHEAT  COIL EST AS DUCT SIZE ALSO  (PRV)
```

111 Supply

4X4X55

4X4X 25

1 Supply

1/2 1ccTORW

ORIGINAL SYSTEMS

June 16, 1982

CONDENSATE LOAD CALCULATIONS (GENERAL):

Energy requirements follow the basic thermodynamic law-

$$Q = \dot{m}\, c_p\, \Delta t$$

$$\frac{BTU}{hr} = \frac{lb}{hr} \times \frac{BTU}{lb\text{-}°F} \times °F$$

Condensate forming within the equipment must equal the total heat output of the equipment (work) plus losses. We will not consider losses until they exceed 10% of the operating load.

Disregarding losses, the energy -or, heat- input should equal the equipments heat output. The result of this heat transfer is the measureable quantity for which a steam trap is to be sized-

$$W = \frac{Q}{h}$$

$$\text{Condensate Load} = \frac{\text{Heat Output}}{\text{Enthalpy Change}}$$

$$\frac{lb}{hr} = \frac{BTU/hr}{BTU/lb}$$

Intuitively we have assumed steady state conditions. Final steam trap selection should be based on maximum operating conditions. When applying a STEAMCARD^{tm} condensate removal device, we should be contacted for any application not having a input steam control valve and having a varying load that can decrease to less than 25% of the maximum condition.

With a superheat steam system, the additional BTU/lb available at the operating pressure of the equipment will result in fewer lb/hr of required steam input. Calculations to determine the percentage of Flash Steam do not change with superheat because this is a function of differential operating pressures.

When it is necessary to derive the load capacity for particular equipment, the applied thermodynamic law is-

$$Q = U\, A\, \Delta t_i$$

$$\frac{BTU}{hr} = \frac{BTU}{hr\text{-}ft^2\text{-}°F} \times ft^2 \times °F$$

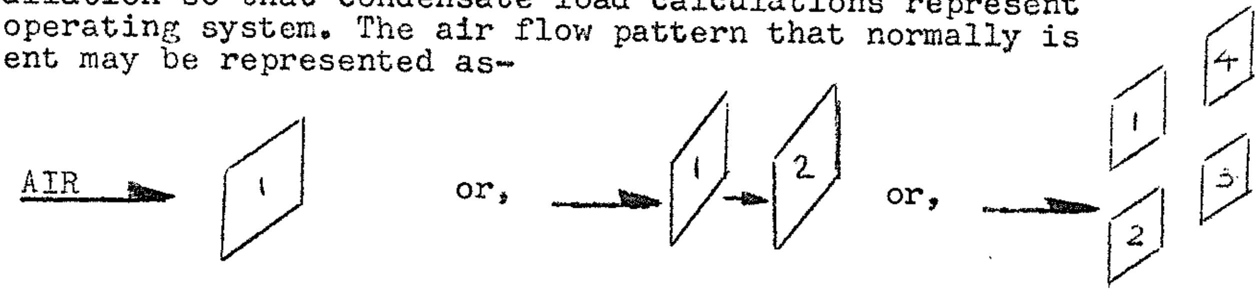
Most important are the necessary assumptions for the Overall Heat Transfer Coefficient. Temperature changes during the cycle greatly affect this equation. Steam trap sizing must consider the maximum load condition which is normally at the start of a cycle.

ORIGINAL SYSTEMS

June 16, 1982

AIR HANDLER UNITS:

It is important to note the actual coil configuration of the installation so that condensate load calculations represent the operating system. The air flow pattern that normally is present may be represented as-



In the second representation above, the first coil could provide 50% more heat load then the second coil. Normally, a 50°F temperature differential per coil is assumed for building ventilation. Unit heaters may easily have a 60°F differential. Whenever possible, the original Equipment Schedule should be referred to so as to accurately determine loads.

Most common are Return Room Air calculations and based on-

$$Q = \dot{m}\, c_p\, \Delta t \quad \text{(per Coil!!)}$$

$$\frac{\text{BTU}}{\text{hr}} = \left(1\ \frac{\text{ft}^3}{\text{min}} \times 60\ \frac{\text{min}}{\text{hr}} \times .075\ \frac{\text{lb}}{\text{ft3}} \times \text{CFM} \right)\left(.24\ \frac{\text{BTU}}{\text{lb-°F}}\right)(\Delta t)$$

$$Q = 1.08\,(\text{CFM})(\Delta t) \quad \text{for 70°F return air}$$

As air conditions change, the "cook book" formula should be altered. As reference, air at 0°F weighs .086 lb/ft3; at 150°F, .065 lb/ft^3. This is a variance of +/-13% from the formula.

At times, very little information is available concerning the coil capacity. Because of duct sizing and sound considerations, room ventilation units may have a velocity between 500 and 1000 ft/min. Actual measurement of the coil will result in an approximate air flow for an average 750 ft/min of-

$$\text{CFM} = \left(750\ \frac{\text{ft}}{\text{min}}\right)(\text{Area}, \text{ft}^2)$$

It is noted that in low pressure (5 psi) steam systems the Equivalent Direct Radiation (EDR) rating may have been given. Although this rating should be corrected for air temperature conditions, steam temperature other than 215°F and altitude, a good low pressure condensate load calculation is-

$$W = \frac{Q}{h} = \frac{\text{EDR}, \text{ft}^2 \times 240\ \text{BTU/hr-ft}^2\text{EDR}}{960\ \text{BTU/lb}}$$

$$W = \frac{\text{EDR}}{4}\ ,\ \frac{\text{lb}}{\text{hr}}$$

ORIGINAL SYSTEMS

June 16, 1982

HEAT EXCHANGERS:

The applicable thermodynamic law is-

$$Q = \dot{m}\, c_p\, \Delta t$$

In most applications the heated medium is water with known standard properties. When allowing for conversion of units and the normally estimated or, given, water pumping rate-

$$Q = \left(Z\ \frac{\text{gal}}{\text{min}} \times 8.33\ \frac{\text{lb}}{\text{gal}} \times 60\ \frac{\text{min}}{\text{hr}}\right)\left(1\ \frac{\text{BTU}}{\text{lb-°F}}\right)(\Delta t)$$

$$Q = (500)(\text{GPM})(\Delta t)\ ,\ \frac{\text{BTU}}{\text{hr}} \qquad \text{(Average!!!)}$$

As stated elsewhere, this is an average load condition. If the unit is used for a batch operation or, if only a short period of time is available to clear all condensate from the heat exchanger, the start-up maximum load condition must be reviewed. Condensate removal should be based on peak load conditions.

$$Q_{\substack{\text{avail}\\\text{max}}} \geqq Q_{\text{peak}} \geqq Q_{\substack{\text{avail}\\\text{mean}}} \geqq Q_{\text{avg}}$$

Assuming that a linear relationship exists between the first calculated Q average-

$$Q_{\text{peak}} = Q_{\text{avg}} \left(\frac{t_{,\text{steam}} - t_{,\text{in}}}{t_{,\text{steam}} - t_{,\text{out}}} \right)$$

The connected equipment must be able to satisfy the peak load demand-

$$Q_{\substack{\text{avail}\\\text{max}}} = U\ A\ (t_{,\text{steam}} - t_{,\text{in}})$$

Classically, heat transfer area selection might only compare the average load requirement to the approximate mean average equipment capacity-

$$Q_{\substack{\text{avail}\\\text{mean}}} \cong U\ A \left\{ \frac{(t_{,\text{steam}} - t_{,\text{in}}) + (t_{,\text{steam}} - t_{,\text{out}})}{2} \right\}$$

It is the Batch Process that must be accurately analized.

June 16, 1982

Process Vessels:

A process vessel is basically a Heat Exchanger having a tank type configuration. The formulas applied to the basic heat exchanger will be applied here as well.

Possibly the greatest difference that exists between a heat exchanger and a jacketed tank or, kettle is the Overall Heat Transfer Coefficient. A heat exchanger normally can exhibit higher steam velocities within a thinner wall shell. The net effect is that a lower heat transfer rate for a given surface area is obtained in the process vessel. Large volumes of the product to be heated must be brought to the heat transfer surface.

Selection of the condensate removal device will be based on the average load when the process is continuous and start-up conditions are no problem. For normally encountered Batch processing, sizing will be based on the peak load.

$$Q_{\substack{\text{avail}\\\text{max}}} \geq Q_{\text{peak}} \geq Q_{\substack{\text{avail}\\\text{mean}}} \geq Q_{\text{average}}$$

$$Q_{\text{avg}} = \dot{m}\, c_p\, \Delta t$$

$$Q_{\text{peak}} = Q_{\text{avg}} \left\{ \frac{t,\text{steam} - t,\text{in}}{t,\text{steam} - t,\text{out}} \right\}$$

$$Q_{\substack{\text{avail}\\\text{max}}} = U\,A\,(t,\text{steam} - t,\text{in}) \quad \text{used as a check}$$

$$Q_{\substack{\text{avail}\\\text{mean}}} \cong U\,A \left\{ \frac{(t,\text{steam} - t,\text{in}) + (t,\text{steam} - t,\text{out})}{2} \right\} \quad \text{area ref.}$$

ORIGINAL SYSTEMS

August 2, 1982

BATCH PROCESSING:

Unlike standard methods used by other trap manufacturers to base condensate loads on average values and rely on inherent Safety Factors during trap selection, the STEAMGARD^{tm} system attempts to both-

a. Continuously remove condensate as it is formed thereby providing maximum Heat Transfer Area to the product.

b. Efficiently reducing live steam loss thruout the process cycle.

Applicable thermodynamic laws are applied with close attention to the peak load near the start of the cycle. STEAMGARD^{tm} selection does require review of condensate loads during the process cycle. A 25% reduction in condensate load as the process continues from start to finish could result in a STEAMGARD^{tm} trap selection that provides for a 99%$^{+}$ energy efficient system.

$$Q_{\substack{\text{avail}\\ \text{max}}} \geq Q_{\text{peak}} \geq Q_{\substack{\text{avail}\\ \text{mean}}} \geq Q_{\text{avg}}$$

$$Q_{\substack{\text{avail}\\ \text{max}}} = U\ A\ (t\text{,steam} - t\text{,in of product})$$

As reported in the May, 1973 issue of Chemical Engineering:

$$Q_{\text{peak}} \cong \frac{U\ A\ (t\text{,steam} - t\text{,in})}{e^{(UA\theta\ /\ mc_p)}}$$

where $\theta = .0083$ hour, or, 30 seconds from start.

$$Q_{\substack{\text{avail}\\ \text{mean}}} = U\ A\ \left(\frac{(t\text{,s} - t\text{,in})-(t\text{,s} - t\text{,out})}{\text{Ln}\ \dfrac{t\text{,s} - t\text{,in}}{t\text{,s} - t\text{,out}}}\right)$$

$$Q_{\text{avg}} = \dot{m}\ c_p\ (t\text{,out} - t\text{,in})$$

Relative to condensate piping, it is always RECOMMENDED to install individual STEAMGARDS^{tm} for each heating Zone available. This method greatly decreases the likelyhood of excessive back-pressure from a zone not having a condensate load to prevent another Zone having a condensate load and attempting to discharge thru a common manifold arrangement.

ORIGINAL SYSTEMS

June 16, 1982

STEAMGARD^{tm} OPERATING PERFORMANCE CHECK:

The concept of continuous flow thru a long nozzle, fixed orifice provides a relatively easy maintenance (or, de-bug) check as to the operating efficiency of the installed device.

When opening the blow-down valve on the Y-strainer, normally only a small amount of condensate should be present. After this small amount of condensate is discharged, live steam at the trap input pressure will begin to be discharged so CAUTION is advised during this inspection. When excessive condensate back-up is found, the operating pressure differential should be noted. Possibly the input line is not functioning or another steam trap on the condensate side has failed open.

Inspection for oversizing will study the condensate return system. If possible, shut-off the Steamgard^{tm} discharge to the return system and allow the unit to discharge to atmosphere. Flash steam may be present but excessive live steam should not be discharged. If the Steamgard^{tm} unit appears to be operating correctly, install a pressure/vacuum gauge on the operating condensate return line to determine how closely this line pressure approximates the steam supply pressure of the system. Further conversion of conventional steam traps feeding this condensate return line is in order.

Whenever inspection of the Steamgard^{tm} system is required because of connected equipment problems, it should be remembered that the device was once de-bugged under maximum operating conditions and it has no moving parts to fail. Is the strainer clean?

Actual collection of condensate and any live steam lost thru the Steamgard^{tm} unit would provide an energy comparison for a known (calculated) equipment output. Without collecting condensate, input steam line orifice plates connected to a recording steam meter or turbine shunt meter may give desired accuracy results.

STEAM TRAPS VS. SECOND GENERATION FIXED ORIFICES

By: Constantine N. Stavropoulos
ENGINEERING RESOURCES, INC.
Chicago, Illinois

Steam conservation is synonymous with energy conservation. Recent discovery of the inefficiency and waste created by steam traps has led to the evaluation and development of other forms of condensate removal devices.

The fixed orifice, although far from being new, can be applied in most applications currently using steam traps. Field results have shown large savings in energy (steam loss), substantial reduction of maintenance and improvements in system efficiency.

March 7, 1979
Chicago, Illinois

CONTENTS

I. INTRODUCTION

The idea of using an orifice as a condensate removal device was probably the first method ever used for that purpose. However, the disadvantage soon became more burdensome than the simplicity and other ideas were developed and pursued.

In order to understand the discontinuation of the use of orifices as the primary means of condensate removal, it is important to examine the development of the steam systems in which they were used and subsequently discarded. Actually it is not surprising when you examine the history of steam generation and use, starting in the mid-nineteenth century. It is easy to understand, or imagine, that the availability of material and the technology to work, form and join them was very limited. As a result, steam generating equipment was crude, dangerous, and operated in such a way as to produce poor quality steam, in both Physical and Thermodynamic senses. As conditions improved and the ability to generate higher pressures and temperatures was achieved, the materials which were quite capable of serving as pressure boundaries for the steam systems, proved to be inadequate for resisting the erosion caused by small, high velocity fluids passing through orifices formed in them. Also, the higher generation rates of the equipment introduced new problems in the form of impurities in the feed water, and side effects of the chemicals used to combat these impurities. The end result was that the two major problems of orifices used to drain condensate were developed. First the erosion of the orifices caused them to be short-life devices which would present maintenance problems, and the second problem was the level of impurities in the system would cause the unprotected orifices to clog and stop working. There were other problems with these steam systems which seemed to make the orifice more unusable. For instance, frequent problems caused a number of shut downs and start ups, and the condensate formed in the piping varied greatly from hour to hour. Also earlier forms of instrumentation were not capable of maintaining uniform pressures at the boiler, causing other maladies like boiler carry over. In fact, it was the recognition of these problems which made the operators of these systems realize the need for devices which would open to large or varying amounts of condensate and close when little or no condensate had to be removed. From that time forth, the steam trap and its many varieties of design and operating characteristics has dominated the condensate removal field.

Now, of course, steam generating equipment is far from crude, materials and the ability to work them are available in all forms. But, we have been living with the steam trap as a condensate removal device for so long, that we have not bothered to explore other approaches to the problem. Of course, what was the problem? Was getting the water out of steam systems the only function of a steam trap? Well, untill recently, not much else was required. However, our energy problems have led us to examine all phases of our steam systems and we've discovered to our extreme surprise, that those "old, reliable" steam traps, which are often very cumbersome to maintain, are wasting so much energy that something has to be done. Now, you may be saying to yourself, "You mean that traps which are not in proper repair are wasting a lot of energy." "Right?" Well, that's not what I mean to say at all. There is *no* steam trap manufactured today, that will not waste energy from its first day in service, and increase its energy loss throughout the time it operates, until it fails. Further, the fact that it will fail is a virtual certainty. This means that, when it fails, and until it is replaced or repaired, it will lose large amounts of steam (hundreds of pounds per hour in most cases.) Surveys in several major plants show an average of ten (10) percent of all traps failed in the open position.

This is not to say that improvements have not been made within the steam trap industry. In fact, there are some excellent steam traps available for services in which it is *necessary* to use a steam trap. What is important is the apparent lack of understanding of steam traps among the people who use them and the weak response by the industry, as a whole, to provide the necessary education and understanding, along with *factual,* reliable data concerning performance.

II. STEAM TRAPS

Steam traps are "thermo-mechanical" devices which are designed to open for the purpose of removing condensate from a system and close to prevent excessive loss of live steam. There are three major categories of steam traps: mechanical, thermostatic and thermodynamic. Each of the types or designs of steam traps represents creative and ingenious forethought in design and development. However, the common fallacy of all steam traps lies within the nature of their operation. That is, the requirement of opening and closing in each cycle of operation, produces wear, fatigue and misalignment of internal parts. All of these lead to eventual failure of the trap and contribute significantly to inefficient operation, prior to failure. The result, of course, is costly maintenance, wasted fuel and expensive parts replacement.

A. MECHANICAL TYPE:

1. **Float** — The float type of trap is simple in its design and purpose. The operation is controlled by the position of a float within a chamber in the trap. As condensate accumulates in the chamber, the float begins to rise and opens the valve to which it is connected by levers and pins. Once open, the pressure within the trap forces all of the water out, the float falls and recloses the valve. The procedure is repeated accurately, until the mechanical parts begin to wear and fatigue, causing misalignment and leakage. The initially small leakage increases as the valve seat begins to erode and eventually large amounts of steam can be lost through the faulty trap.

2. **Inverted Bucket** — The inverted bucket type of steam trap, like the float trap, takes its name from its mechanical configuration. The working mechanism is an "inverted" or upside down, bucket or cup. The principle of operation resembles the effect of trying to submerge an empty glass, open end first, into a sink full of water. As the steam and condensate enter the bottom of the trap and are exposed to the open end of the inverted bucket, the water forms a seal around the edges of the bucket, and steam fills the bucket, causing it to float. Attached to the top or closed end of the bucket is a valve mechanism which closes the trap as long as the bucket floats. As more water enters the trap, and the steam in the bucket begins to condense, the bucket sinks and opens the trap. Like the float trap, the valve area is subject to wear and misalignment, causing erosion and leakage. Also the trap operation causes a small amount of condensation of live steam and therefore, "consumes" a small amount of steam in its operation. The effect of this is increased in colder weather.

B. THERMOSTATIC TYPE:

1. **Bellows** — The bellows type of trap is also relatively common and operates on the thermostatic, or temperature change principle. The bellows is an expandable, corrugated cylinder which is filled with a liquid having a boiling point different from the water in the system in which it operates. When the outside of the bellows is exposed only to steam, the high temperature causes the liquid inside the bellows to become a gas. The change of volume of the internal substance and the increase in pressure inside the bellows caused by that change of volume, makes the bellows expand, a valve mechanism attached to the end of the bellows closes the trap. As condensate enters the trap and cools the bellows, the fluid on the inside starts to condense. This condensation allows the bellows to contract and opens the trap.

2. **Bimetallic** — The bimetallic type of trap is also thermostatic in its operation. Two pieces of dissimilar metal are bonded together to form a single strip. The change in temperature caused by the alternate presence of steam and condensate causes the metals to expand and contract. Being dissimilar in nature, the amount of expansion and contration differs, causing a movement in the single strip. This movement is used to open and close the valve.

Both types of thermostatic traps have similar drawbacks. Their nature of operation causes them to react slowly and therefore, they are wasteful of energy. The installation requirements are such that they make these traps extremely vulnerable to freezing.

C. THERMODYNAMIC TYPE:

1. **Disc** — The disc type of thermodynamic trap is the most common trap of any kind in use. They are often referred to as "TD" traps. They consist of a heavy, flat disc enclosed in a trap body, constructed so that the weight of the disc causes it to lay flat and act as the valve seat. When the space above the disc is filled with steam, the weight of the disc and the steam pressure acting over its area, forces the trap to remain closed. As the steam loses heat through the trap body, it condenses and allows the system pressure to force the disc off its seat and the trap opens. You will notice that this cycle occurs without the influence of the presence or absence of condensate. Therefore, the trap operates purely on a time cycle which is governed by the rate of heat loss through the trap body. For this reason, and because this trap is prone to rapid failure, it has become the most offensive energy waster of any of the steam traps available. The popularity of this trap was established when it was manufactured in a form which allowed the internal working parts to be replaced without removing the trap body from the piping system, thereby saving maintenance time and money.

These brief descriptions are, in no way, intended to be comprehensive or complete, however, they should provide some insight into the various problems associated with the different types of traps.

III. FIXED ORIFICES

A. Operation

The operation of a fixed orifice as a condensate removal device is relatively simple and straight forward. In a given pressure system, (i.e., known inlet pressure and known outlet pressure), an orifice of a given diameter will be able to discharge a known amount of saturated water (condensate) saturated or superheated vapor (steam) or a mixture of saturated water and saturated vapor. The most outstanding benefits of this type of system include the following:

1. Continuous discharge of condensate, resulting in maximum efficiency of the connected equipment;
2. Absence of moving parts, which makes them virtually maintenance free; and
3. Inability of the orifice to "fail open," wasting large amounts of steam, as traps do.

The key characteristic of fixed orifices with regard to "energy efficiency," is the difference in the discharge capacities of a given orifice, with reference to the flow rate of liquid compared to the flow rate of vapor, through the orifice.

B. Performance under Varying Loads:

For example, with a 100 psig inlet and a 0 psig outlet, an orifice with a diameter of 0.020" has a capacity of 33 #/hr. of saturated water. In the same pressure conditions, the same orifice has a capacity of only 1.86 #/hr. of live steam. With this large difference in mass flow rates and with the principles of two-phase flow (the condition whereby both vapor and liquid pass through the orifice as a mixture) through an orifice, which state that while the liquid and vapor pass through the orifice, each occupies its own volume within the orifice; it can be seen that small orifices can be provided to discharge condensate loads which *can vary* greatly and still pass only small amounts of live steam with them. This characteristic is applied by calculating the condensate load requirement for a given condition and then increasing it by a multiple ranging from 1.0 to 2.0 depending upon the type of application. This allows the orifice to operate efficiently through load changes which can be as great as 100%, without being too small to pass the required load and without passing an amount of live steam which would be as large as or larger than the amount lost by a *new* trap in the same application. For example, consider the conditions given previously for a 0.020" orifice having an inlet pressure of 100 psig and an outlet pressure of 0 psig. If that orifice were installed to remove the condensate in a drip leg of a 6", insulated steam line, draining 100 feet of the header, the requirements would meet the flow rates of the orifice. That is, the predicted condensate would be approximately 22 #/hr., this would be increased by a factor of 1.5, so that the orifice would be sized to pass 33 #/hr. of condensate. This oversizing provides a safety factor of 50% and leaves roughly 1/3 of the orifice area available to pass live steam. Using standard calculations for this two-phase flow condition, the amount of steam loss through the "available" 1/3 of the orifice's area can be found as a percentage of the total steam capacity of the orifice, if no condensate were present. In this case the percentage is 13, in other words, 13% of 1.86 or 0.24 lbs./hr. [3] of steam would be lost, during the normal condition, when the orifice was removing 22 #/hr. of condensate. With different conditions and applications, these numbers will vary, however, *in every case where the orifice is the proper condensate removal device, the amount of live steam loss will be less than the amount lost by a new trap in the same application.*

[3] See appendix for formulas used in example.

C. Application Examples:

Perhaps the most basic use of condensate removal devices is to remove the condensate from headers which distribute the steam from the boiler to various parts of the plant. Two cases generally exist, saturated steam or superheated steam is being transported through the header. These two conditions are entirely different and shall be discussed separately.

1. **Saturated Steam Systems** — In the case of saturated steam, condensate is produced within the line, due to the radiant and convection type heat losses to the ambient. The amount of heat loss will vary with the average ambient and with the amount of insulation used to reduce the heat loss,

but, with these normal conditions accounted for, the fluctuation or change in the amount of heat loss will change only with the ambient changes, such as the change of seasons, etc. There are two very important characteristics which make this application ideal for the orifice. First, the condensate is produced by a *continuous* heat loss, and second, the amount of condensate being produced is small (i.e., in systems from 2 to 450 psig, the loads will vary from 5 to 60 #/hr.) Finally, the change in load is relatively small and is very predictable, giving more support to the idea of a condensate removal device which will perform efficiently without maintenance and without the capability of failing open and losing hundreds of pounds of steam per hour, until it can be detected and repaired.

2. **Superheated Steam Systems** — In the case of superheated steam line drains the performance difference is even more dramatic. Current design trends for new installations are leaning toward the elimination of as many drain points on superheated lines, as possible. The reason, of course, is that there is no requirement for condensate removal, once the line is up to temperature, and in service. Existing installations, for the most part, are fitted with drain points in the same manner as their saturated counterparts. Therefore, some type of condensate removal device must be installed to prevent the accumulation of condensate in these drip legs. *There is no steam trap on the market that can perform this job efficiently or consistently.* The reasons are fairly simple. Since there is no condensate being formed, a closed steam trap creates a "dead end line," which causes the steam to cool and fall into the saturated zone. At this point, condensate begins to form and the trap will open. This process is actually a type of "steam consumption" by the trap. This cycle will be repeated until, depending upon the type of trap, severe erosion prevents closing of the trap, or in the case of the inverted bucket trap, the water seal is lost. In any case, trap life in this application is normally very short. The orifice is an excellent solution to the many mechanical problems suffered by the traps because it has no wearable parts, requires no water seal, and has no fail open mode. The orifice will definitely lose steam in this application because, essentially, that's all that will be present at its inlet. However, as stated before, this loss will always be less than the amount lost by a trap in this application.

3. **Steam Trace Heating** — Another application which is very well suited for the orifice is steam trace heating. Here again, the type of load and the method in which it is created have a great bearing on the proper manner of removing the condensate from the system. In steam tracing, iron pipe, copper tubing or stainless steel tubing, are placed spirally around or parallel to the outside of a product or water pipe for the purpose of maintaining a temperature for the material in the pipe, or to prevent freezing. Usually, insulation is placed around the tubing and piping to reduce the heat loss from the system. Again, the physical parameters of this system are such that a uniform heat loss rate is established over each foot of length of the tracer. It is essential that this continuously produced condensate be removed *continuously.* Since the cyclic operation of a trap will change the heat transfer of the system and allow the possibility of condensate being backed up in the tracer, the temperature maintenance capability will be reduced and there will be the possibility of freezing, which is supposed to be one of the things that the system prevents. The most common trap in use on tracing systems is the thermodynamic disc trap. Tests have shown a consistent savings of more than 20 #/hr. of live steam in tracing systems comparing these disc traps to orifices.

4. **"Dry Can" Heaters** — An application which is of particular interest to the textile industry is the condensate removal from "dry cans," the rotating cylinders which are heated by steam in order to dry various types of fabrics which are passed over them. The critical feature of this system is the ability to maintain a uniform and constant temperature in each of the several cans in each group or "rack." The more uniform the drying process, the more uniform the quality of the product and the faster the units can be operated. Current practice is to use inverted bucket traps on each individual dry can, with the traps exhausting into a common return system. Again, taking into account the cyclic operation of these traps, it can be seen that a uniform temperature is unlikely over the surface of each individual roll, let along the uniformity of the collective rolls. Further, as the traps fail open the temperature of the rolls will drop, each independent from the other, causing production speed and quality problems. Further, the overpressurization of the common exhaust system, changes the operation of the other traps. A major textile plant in the U.S.A., with an energy cost of $6.00/1,000 #/hr. for steam, has tested orifices in this application and obtained the following results. The energy consumed per roll was reduced by 45%, the speed of the rolls was increased, and the back pressure which used to vary from 40 to 50 psig, was reduced to 10 psig.

D. Fixed Orifice Performance Under Steam Pressure Variations:

This section describes a characteristic of steam distribution system that is said, by the critics of the orifice, to have an adverse affect on the performance of the orifice. That condition being the variation of pressure throughout the system due to load changes and piping heat losses.

1. **Inlet Steam Pressure Variations** — For example, it is conceivable that a 400 psig system providing steam to a number of plant locations could, through these various losses, be providing pressures as low as 325 psig in the plant extremities. The effects of these pressure changes are governed by the same principles that govern the operation of the orifice, these principles being the basic laws of thermodynamics. With the drop in pressure, in saturated conditions, comes a number of property changes, including temperature and specific volume. Since temperature has a direct influence on heat loss from the steam line, and since pressure and specific volume are important factors in the determination of orifice capacity, the end result is a compensation by the orifice, with regard to the changes in conditions. For example, an 8" header with a 400 psig pressure and a given ambient condition, will produce a predictable amount of condensate per foot of its length. If all conditions remain the same, except pressure, the reduction of pressure to 200 psig (50% of its original value) will reduce the condensate production in the header by approximately 31%. An orifice sized to handle the conditions at 400 psig will have its capacity reduced, when the pressure drops to 200 psig, by some 27%. Thus, the load decreases more than the capacity of the orifice decreases, and the orifice will have *no* problem performing just as efficiently at the reduced pressure. Not all condition changes are proportional to this example; however, these changes must *always* be considered in the selection of sizes for a given application so that they will not affect the proper operation of the orifice.

2. **Back Pressure Variation** — With respect to back pressure or exhaust pressure changes, it must be recognized that only a few major factors influence large fluctuations in back pressure. First, a basic design error, which provides a system too small to handle its requirements. Second, the addition of equipment which causes an overload of an existing system, and last, but by no means least, is our friend, *STEAM TRAP FAILURE.* Since either of the first two alternatives are usually detected and corrected within a reasonable amount of time after the units are in service, it is obvious that the day-to-day "ups and downs" of the back pressure system are caused by the excessive discharge of failing steam traps. Further, this begins a "chain reaction" which leads to the loss of efficiency of other steam traps discharging into the same system as the failed steam trap, and their eventual, sometimes premature, failure. These fluctuations are also devastating influences on system operating efficiencies and can cause slowed production rates. The orifice is again an obvious solution and improvement, as it has no capacity to fail open and overload the exhaust system. Further, it offers a unique advantage to the designer, in that, he can now accurately predict discharge flows and expect the steady state conditions for which he has designed the rest of the system.

E. Steam Trap Comparison

Studies and tests have shown substantial fuel savings and virtual elimination of maintenance when the fixed orifices replaced conventional steam traps. To illustrate the impact of these differences on plant operation, let us consider the case of a California refinery. Comparison tests on the heat tracing system at this refinery have shown the following:

Type of Condensate Removal Device	**Avg. Steam Consumed Lbs./Hr.**
Steam Traps, thermodynamic, type "A"	64.0
Fixed Orifices	42.0
Difference: 22.0 Lbs/Hr/Trap of steam	

If the plant section has 1,000 steam traps, then the savings will be:
Steam Savings = 22,000 Lbs./Hr.

Considering that the cost of steam is minimum $3.50/1,000 lbs., then
Fuel Savings = $77.00/Hr. or
Fuel Savings = $554,400/Yr. minimum.

The maximum average installed cost for installing fixed orifices on these applications is $100.00/orifice, or $100,000 for the above plant section. The result is that the period for return of the total investment for converting to fixed orifices is less that six months.

In plants with large steam consumption, the results are even more dramatic. In several cases the total cost of converting the steam traps to fixed orifices, it was less than fuel savings for one month. In addition to the above, all these plants experienced a virtual elimination of maintenance costs.

IV. CONCLUSIONS

In most applications the fixed orifices have a distinct advantage over the steam traps now used to remove condensate from steam systems.

It is not hard to understand the degree of skepticism which exists with regard to the performance of the orifice in the condensate removal systems. It appears to be "too good to be true" and too simple. It is relatively simple, but it is only the advance in related technology and engineering as well as the new and better understanding that we have of the steam systems, and the new materials available for use in them, which has made it possible to effectively return to this old idea.

There is now a very substantial accumulation of data available regarding the performance of orifices in condensate removal systems, including, but not limited to, eight years of testing and acceptance by the United States Navy. There is unquestionable evidence of large energy savings and elimination of troublesome maintenance requirements. The industries included in the testing and use of orifices are the following groups: the petrochemical, paper, steel, manufacturing, pharmaceutical and textile industries, as well as applications in heating and air conditioning systems of office buildings.

It is an idea whose time has come and with it comes the obsolescence of the steam trap in the applications where the orifice can be used.

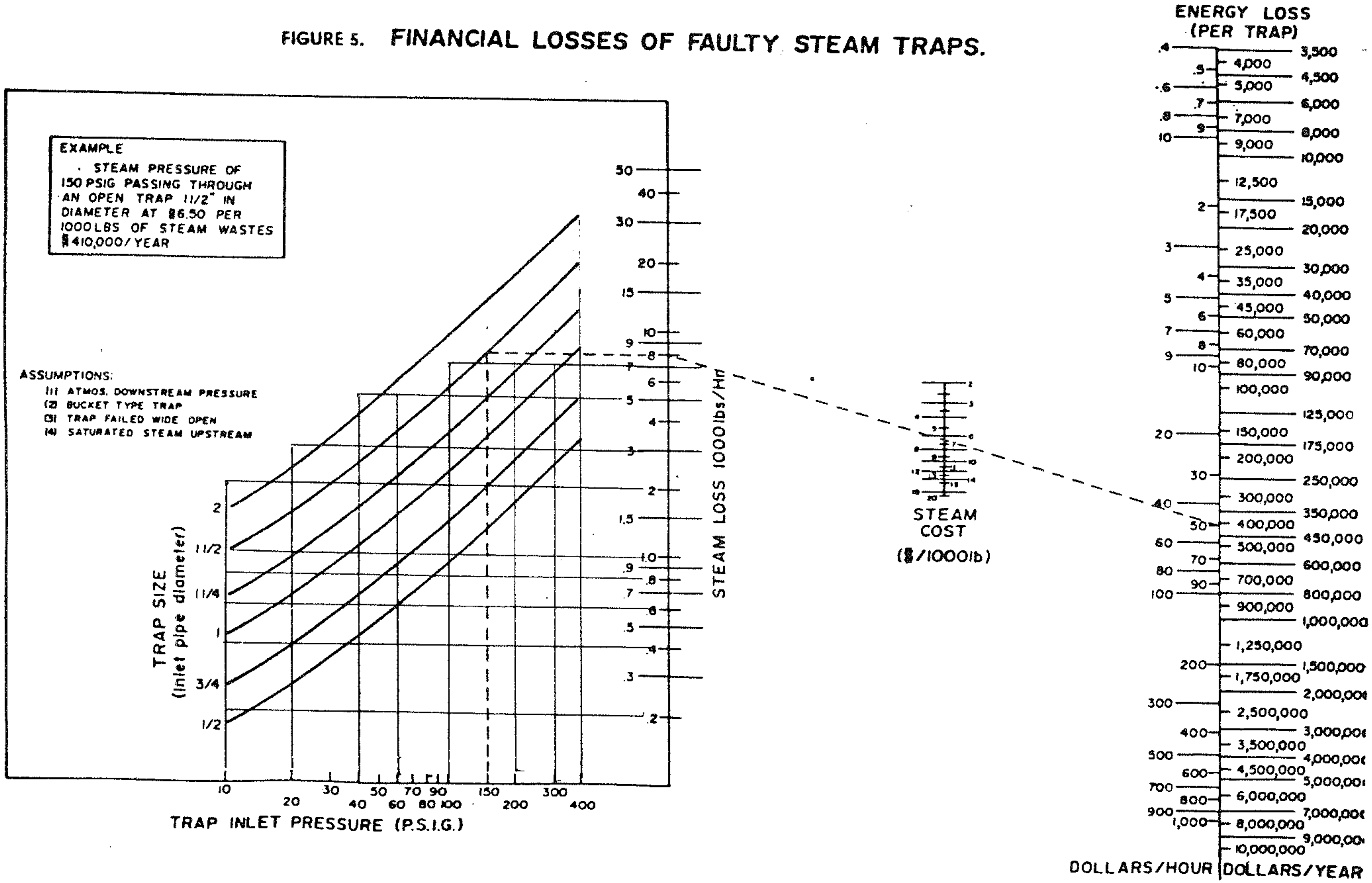
APPENDIX

The formula used to calculate the flow of saturated water through a cylindrical orifice is as follows and is taken from: "Fluid Meters — Their Theory and Application," Edited by H. S. Bean, American Society of Mechanical Engineers, 6th Edition, 1971.

$$W = \frac{1890\, C_d\, Y\text{-}d^2\text{-}F_a \sqrt{\Delta p/v_1}}{\sqrt{1-(d/D)^4}}$$

Where: W = Flow through orifice, #/hr.
C_d = Coefficient of discharge
Y = Expansion factor
d = Diameter of orifice
F_a = Area Factor
Δp = Pressure differential across orifice
v_1 = Specific Vol. of fluid at inlet
D = Internal pipe diameter

FIGURE 5. **FINANCIAL LOSSES OF FAULTY STEAM TRAPS.**



EXAMPLE

· STEAM PRESSURE OF 150 PSIG PASSING THROUGH AN OPEN TRAP 11/2" IN DIAMETER AT $6.50 PER 1000LBS OF STEAM WASTES $410,000/YEAR

ASSUMPTIONS:

(1) ATMOS. DOWNSTREAM PRESSURE
(2) BUCKET TYPE TRAP
(3) TRAP FAILED WIDE OPEN
(4) SATURATED STEAM UPSTREAM

Williamson

1152 Main Street, Concord, MA 01742
Tel. (617) 369-9607, (617) 259-9307, Telex 923343

MEASUREMENTS AND CONTROLS SEPTEMBER 1979

EXPERIMENT #1

STEAM MISER VS. CONVENTIONAL STEAM TRAP - VISUAL

Disconnect the existing conventional steam trap from condensate return line. The steam trap is now vented to atmosphere.

In general, a steam trap is a cyclical device. A properly sized steam trap opens periodically to discharge the accumulated condensate. A continuous discharge of condensate usually indicates that the steam trap is undersized for the application; while a continuous discharge of condensate accompanied by severe steam leakage, usually indicates a steam trap which has failed in the open mode. A steam trap with the aforementioned symptoms of malfunction should be replaced to insure the validity of the comparison test.

Observe the performance of the steam trap during discharges and between discharges. At the beginning of the discharge portion of the cycle of the steam trap, the make-up of the discharge is, as a rule, almost all condensate. A "cloud of steam" accompanying the discharge of condensate is NOT necessarily caused by leakage of live steam. This may simply be what is known as "FLASH STEAM." Flash steam is the direct result of discharging condensate at pressures higher than atmospheric to the atmosphere. The leakage of LIVE STEAM is usually observed just before and after the steam trap closes. Live Steam, or simply steam, like air, is NOT VISIBLE. The discharge of steam through a restricted opening is always accompanied by a characteristic "HISSING" sound. Therefore, an easy way to observe STEAM LEAKAGE or LOSSES is by listening.

Leakage of steam just before the steam trap closes is caused by the inherent time delay of the response of the steam trap to changing conditions. The slow responses to changing conditions is a deficiency of any mechanical, thermal or mechanical/thermal device. Although this time delay may be reduced, it is unavoidable. A time delay of several seconds is typical. Leakage of live steam, continuing after the steam trap closes, is caused by poor design, misalignment, corrosion, erosion, uneven build-up of scales and others.

Sometimes, it is possible to estimate the relative magnitude of the steam losses by carefully observing the region immediate to the discharge portion. Severe steam losses will result in a clear or transparent jet at the discharge port accompanied by the hissing sound. The length and size of this jet is proportional to the magnitude of the steam losses. Often, the observation is rendered difficult by the "CLOUD" of condensed vapor.

Install the STEAM MISER specified for the direct replacement of the existing conventional steam trap and observe the performance as before. The performance of the STEAM MISER should be as follows:

A. A steady stream of condensate accompanied by some visible flash steam. The CONTINUOUS removal of condensate is very evident.

B. An occasional burst, duration of which, is a small fraction of a second, propelling the condensate to a distance several times greater than normal for the condensate. These bursts of live steam are very short in duration and happen only occasionally. Therefore, the amount of steam loss is minimal. It is not unusual if these short bursts are totally absent for your experiment.

This experiment, though lacking in its quantitative definity, does provide a simple and clear demonstration of differences in the performance of a STEAM MISER versus a conventional steam trap.

Engineering Resources, Inc.

EXPERIMENT #2

STEAM SAVINGS - STEAM MISER VS. CONVENTIONAL STEAM TRAP

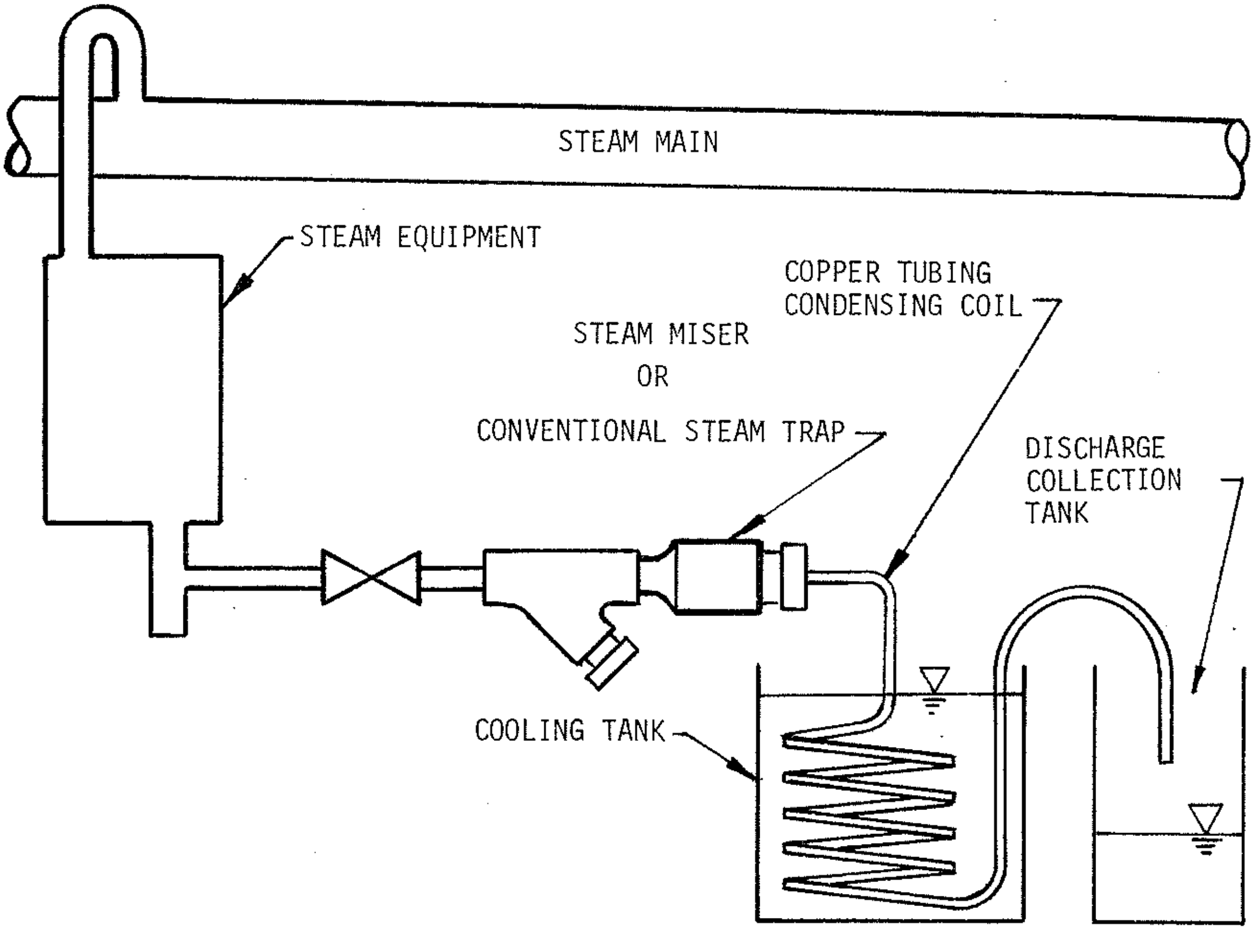


FIGURE (1) TEST SETUP

INTRODUCTION

The test is designed to measure the reduction of steam losses with the use of STEAM MISER and to confirm visual observations made in Experiment #1. In this test, the steam loss is equal to the total weight of the discharged mixture of steam and condensate into a condensate tank for both the conventional steam trap and the STEAM MISER. (See Figure 1 for the test setup.)

PROCEDURE FOR TESTING

A 1. Connect copper tubing to the discharge port of a conventional steam trap. Submerge the copper tubing in a bath of cooling water to fashion a condensing coil.

A 2. Make sure the condensate is not being "backed-up" on a continuous basis. A conventional trap will tend to back-up condensate during the closed portion of each cycle. This is an inherent deficiency of steam traps and is not our immediate concern.

A 3. Measure the surface temperatures of the steam line a few inches upstream of the entry port, T_{in}, and of the copper tubing a few inches downstream of the discharge port, T_{out}. These temperatures vary with time for conventional steam traps. Use an average of the readings.

A 4. Determine the weight of the condensed discharge of normal condensate and live steam for steam trap over a selected period of time.

B 1. Repeat the test using a STEAM MISER specified for the direct replacement of the above conventional steam trap.

RESULTS

C 1. CALCULATE THE SAVINGS IN $'s (DOLLARS.) The difference in weight of the condensed discharge will show the reduction in steam losses achieved by the STEAM MISER.

For example, the weight of the discharge for the STEAM MISER is 100 pounds per hour and 120 pounds per hour for the steam trap; the difference in weight is the excess steam loss of 20 pounds per hour. The savings is 20%. The annual savings based on a conservative cost of steam of $6.50/1000 lbs. is:

$6.50/1000 x 20 x 24 x 365 = $1,138.80 per year.

C 2. SIGNIFICANCE OF THE TEMPERATURE MEASUREMENTS. Downstream temperature, T_{out}, for the steam trap will be higher than that for the STEAM MISER. This is the direct result of the reduction of steam losses.

Conversely, the upstream temperature, T_{in}, for the steam trap will be lower than that for the STEAM MISER. This is caused by the periodical closing of the steam trap which results in condensate "backing-up" and lowering the inlet temperature. This cyclical "backing-up" reduces the efficiency of a steam system. This reduction of efficiency should cause a corresponding reduction in steam consumption and, thus, the weight of the condensed discharge. In general, the difference in the weight of the discharged mixture accounts for only a portion of the savings, not necessarily all of the savings.

INDEX

The SteamGard™ System.

The STEAMGARD System is a combination of stainless steel nozzles, strainers, screens and applications engineering knowledge. This simple system (there are no moving parts) is used as a direct replacement for steam traps in virtually any application requiring condensate removal.

The unit itself, which comes in 1/2", 3/4" and 1.0" pipe sizes (NPT, BSPT or welded connections) can handle steam pressures to 2000 PSI. STEAMGARD should be used with a strainer having a special stainless steel screen insert.

Engineering a nozzle that will effectively discharge the condensate in a steam system and inhibit live steam loss is the most important step in incorporating STEAMGARD into any system.

The STEAMGARD System is based on the physics of two-phase flow. Steam and condensate are trying to get through the same fixed nozzle. Since condensate (liquid) at 20 PSIG is over 700 times heavier than an equal volume of steam (vapor) it is difficult for the steam to get through the nozzle with the condensate.

Steam (20 PSIG) occupies 12.01 FT.^{3}/LB. As the steam pressure goes higher, the specific volume is lower.

Condensate capacities are proportional to the square root of the steam pressure.

A STEAMGARD Model -05 operates as follows:

PRESSURE DIFFERENTIAL	CONDENSATE DISCHARGE
20 PSIG	77 LB/HR.
40 PSIG	108 LB/HR.
120 PSIG	184 LB/HR.
600 PSIG	390 LB/HR.

HOW STEAMGARD SYSTEM SAVES

The STEAMGARD System, when used as a trap replacement or in a new installation, will save costs three ways.

Most importantly, the STEAMGARD System has no moving parts and cannot "fail open." The STEAMGARD System eliminates the huge potential steam losses caused by "blowing-through" traps.

The STEAMGARD System also reduces labor and material costs associated with trap maintenance. Since it has no moving parts, there is no need for repair parts. Labor is limited to periodically checking the protective strainer.

Probably the most dramatic savings is in initial cost. The STEAMGARD System units cost from $60.00 to $120.00. Our largest unit can many times do the work of more than one trap. It is not uncommon to replace traps that have repair kits costing over $300.00. The STEAMGARD System is also easier to work with. A 1.0 inch STEAMGARD with strainer (5.4 lbs.) can replace traps weighing over 200 pounds.

STEAMGARD SYSTEM APPLICATIONS AND RESULTS

The STEAMGARD System is presently being used in almost every type of steam system with outstanding results. Facilities all over the world are using the STEAMGARD System on a wide variety of both commercial and industrial applications. Many of these facilities chose this System after conducting extensive trap evaluation programs.

HOW TO ORDER STEAMGARD

1. In order to select STEAMGARD models for specific applications, use the convenient sizing tables in this Catalog.

2. When ordering STEAMGARDS, specify:

XXX" SGX-B-XX

MODEL NUMBERS: 01 TO 25

'BLANK' FOR MODEL NUMBERS 01 TO 20
'L' FOR MODEL NUMBERS 21 TO 25

PIPE SIZES (NPT ANSI B2.1 1968):
1/2 - MODEL NUMBERS 01 TO 15 ONLY
3/4 - MODEL NUMBERS 01 TO 20 ONLY
1.0 - MODEL NUMBERS 01 TO 25 ONLY

*Maximum steam temperature 900° F.
Special STEAMGARDS are available for high temperature applications.

*STEAMGARDS can replace steam traps over 1.0" pipe size. Simply reduce existing piping from current size to the 1.0 inch STEAMGARD pipe size.

3. When ordering STRAINERS, specify:

Pipe sizes and quantities of each size,
Steam pressure over 250 PSIG, and
Steam temperature over 406° F.

*Unless otherwise specified, semi-steel Y-Strainers with a stainless steel screen basket insert with 0.020 inch maximum openings (40-Mesh) rated at 250 PSIG maximum steam pressure and 406° F temperature will be supplied.

*High pressure strainers available on special orders.

Ductile iron	600 PSIG	650° F
Stainless Steel 316	600 PSIG	1125° F

4. For sizing assistance on applications not found in this Catalog, contact Engineering Resources, Inc., applications group or your closest ERI engineering representative.

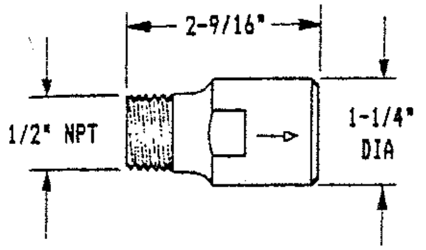
5. STEAMGARD delivery is usually within five (5) working days.

WARRANTIES

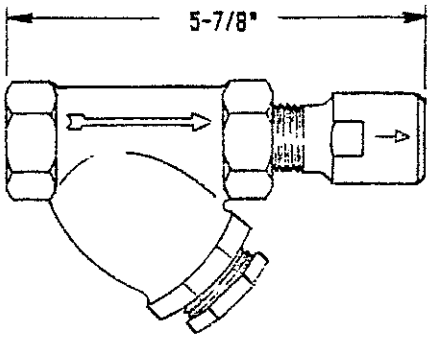
STEAMGARD is guaranteed for a period of three (3) years from shipment against defects in material and workmanship. Engineering Resources does require that STEAMGARD be installed downstream of a strainer with 40 mesh stainless steel basket insert (maximum .020 openings.)

DIMENSIONS AND PIPING DIAGRAMS

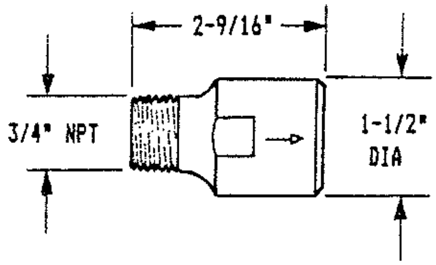
STEAMGARD® DIMENSIONS



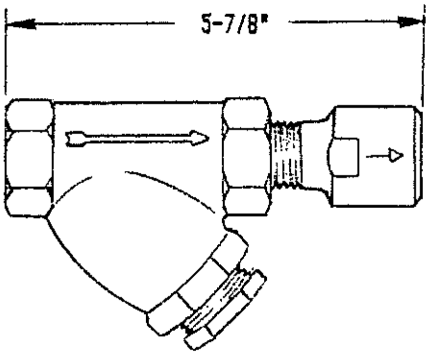
1/2 INCH STEAMGARD



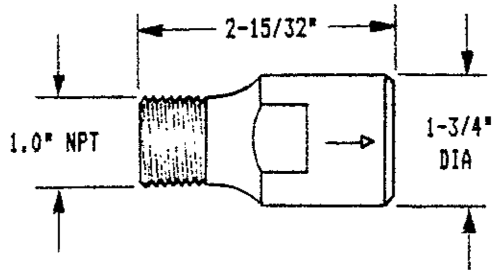
1/2 INCH ASSEMBLY



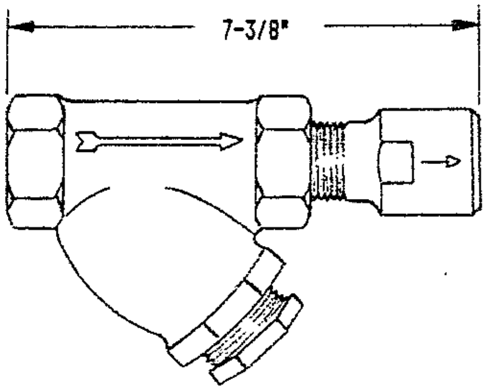
3/4 INCH STEAMGARD



3/4 INCH ASSEMBLY



1.0 INCH STEAMGARD



1.0 INCH ASSEMBLY

NOTES:

(1) ALL STAINLESS STEEL CONSTRUCTION.
(2) AMERICAN NATIONAL STANDARD TAPER PIPE THREAD - ANSI B2.1 (1968).
(3) 1/2 INCH STEAMGARDS AVAILABLE IN MODELS -01 TO -15 ONLY.
(4) 3/4 INCH STEAMGARDS AVAILABLE IN MODELS -01 TO -20 ONLY.
(5) 1.0 INCH STEAMGARDS AVAILABLE IN ALL (25) MODELS.

	WEIGHT			OVERALL LENGTH IN INCHES		
PIPE SIZE	1/2 INCH	3/4 INCH	1.0 INCH	1/2 IN	3/4 IN	1.0 IN
STEAMGARD	0 LB 8 OZ	0 LB 11 OZ	1 LB 2 OZ	2-9/16	2-9/16	2-31/32
STRAINER	2 LB 4 OZ	2 LB 3 OZ	4 LB 4 OZ	3-7/8	3-7/8	5-
ASSEMBLY	2 LB 12 OZ	2 LB 14 OZ	5 LB 6 OZ	5-7/8	5-7/8	7-3/8