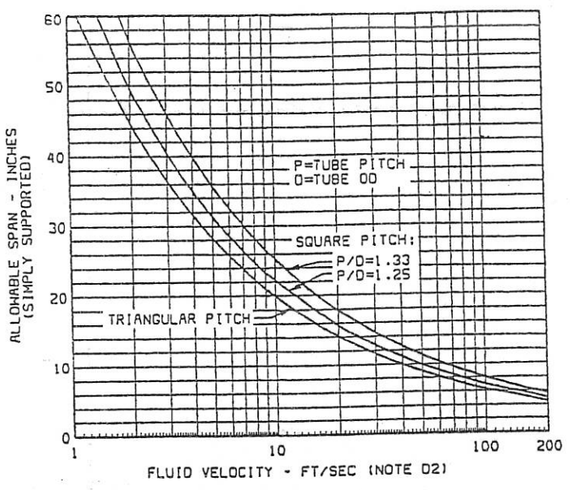


FIGURE 1

ALLOWABLE SPANS FOR PERIPHERAL TUBES IN INLET AND OUTLET REGIONS

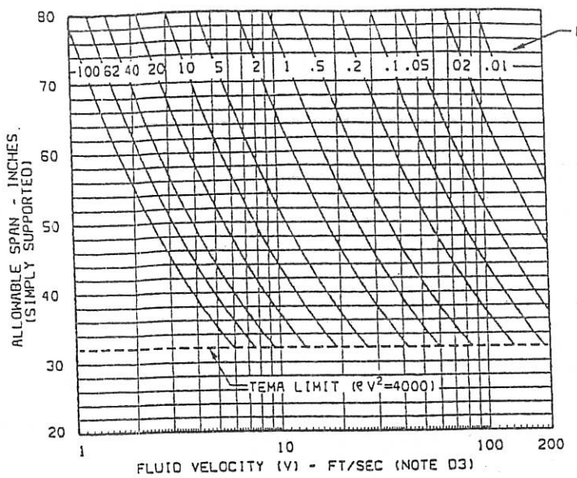


FIGURE 2

ALLOWABLE SPANS FOR INTERIOR TUBES

FIGURE 1 ALLOWABLE SPAN MULTIPLIERS

| ITEM | MULTIPLIER |
|---|---|
| 1. TUBE SIDE FLUID: | |
| VAPOR | 1.00 |
| TWO PHASE | INTERPOLATE |
| LIQUID | 0.95 |
| 2. SHELL SIDE FLUID: | |
| VAPOR | 1.00 |
| TWO PHASE | INTERPOLATE |
| LIQUID | 0.85 |

COMMON ALLOWABLE SPAN MULTIPLIERS

| ITEM | | MULTIPLIER |
|---|---|---|
| 1. END SUPPORT: | | |
| SUPPORT PLATES AT ENDS | | 1.00 |
| TUBE SHEET AT ONE END | | 1.25 |
| 2. TUBE SIZE: | | |
| 3/4" OD | | 1.00 |
| 1" OD | | 1.25 |
| 3. MATERIAL AND GUAGE: | | |
| CARBON STEEL | 13 BWG | 1.00 |
| CARBON STEEL | 14 BWG | .98 |
| STAINLESS STEEL | 10 BWG | 1.05 |
| STAINLESS STEEL | 14 BWG | .97 |
| STAINLESS STEEL | 16 BWG | .93 |
| COPPER NICKEL | 16 BWG | .84 |
| ADMIRALTY | 16 BWG | .81 |
| TITANIUM | 16 BWG | .81 |
| TITANIUM | 20 BWG | .71 |
| ZIRCONIUM | 20 BWG | .69 |

FIGURE 2 ALLOWABLE SPAN MULTIPLIERS

| SHELL-SIDE VOLUME VAPOR FRACTION | MULTIPLIER |
|---|---|
| 0.0 | 1.00 |
| 0.1 | 1.07 |
| 0.2 | 1.13 |
| 0.3 | 1.18 |
| 0.4 | 1.23 |
| 0.5 | 1.27 |
| 0.6 | 1.21 |
| 0.7 | 1.14 |
| 0.8 | 1.06 |
| 0.9 | 0.96 |
| 1.0 | 0.81 |

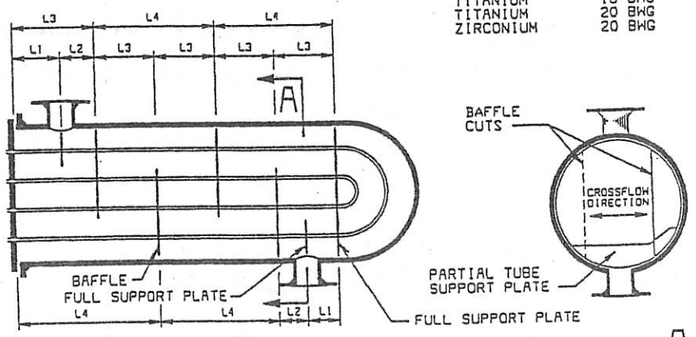


FIGURE 3

UNSUPPORTED TUBE SPANS (L1, L2, L3 & L4)
(SEE SECTION A FOR TRUE CROSSFLOW DIRECTION)

SECT. A

## GENERAL NOTES

G1. THIS DRAWING DEFINES MAXIMUM UNSUPPORTED STRAIGHT TUBE LENGTHS IN SHELL-AND-TUBE EXCHANGERS TO PREVENT FLOW INDUCED TUBE VIBRATION.

G2. U-BEND VIBRATION IS PREVENTED BY NOT ALLOWING SHELL SIDE FLOW IN THE U-BEND REGION BY USING A FULL SUPPORT PLATE AS SHOWN IN FIGURE 3. EVALUATION OF U-BEND VIBRATION WITH EXTERNAL FLOW IS BEYOND THE SCOPE OF THIS DRAWING.

G3. FIGURE 1 IS BASED ON VORTEX SHEDDING AND APPLIES ONLY TO PERIPHERAL TUBES IN THE INLET AND OUTLET REGIONS THAT ARE SUBJECT TO NOZZLE FLOW. L1 AND L2 OR L3 MAY BE THE ONLY TUBE SPANS INVOLVED IF CIRCUMFERENTIAL PERIPHERAL FLOW IS BLOCKED BY SEAL BARS EXTENDING TO THE TUBE SHEET AND TO THE FULL SUPPORT PLATE NEAR U-BENDS. L4 MAY BE SUBJECT TO NOZZLE FLOW IF SEAL BARS DO NOT EXTEND INTO INLET AND OUTLET REGIONS. PERIPHERAL TUBES ARE CONSIDERED TO BE THE FIRST THREE OUTERMOST ROWS OR COLUMNS OF TUBES.

G4. FIGURE 2 IS BASED ON FLUID ELASTIC WHIRLING AND APPLIES TO ALL STRAIGHT TUBE SPANS. L4 IS USUALLY THE ONLY SPAN LIMITED BY FIGURE 2.

## DESIGN NOTES

D1. SHELL SIDE FLOW RATE FOR VIBRATION ANALYSIS PURPOSES SHALL BE 125 PERCENT OF DESIGN FLOW RATE UNLESS SPECIFIED OTHERWISE. THIS IS AN ARBITRARY ALLOWANCE FOR OVER DESIGN FLOW DUE TO OVER-SIZED PUMPS, FUTURE PLANT DEBOTTLENECKING OR OTHER CAUSES. MORE OVER-DESIGN MAY BE APPROPRIATE FOR PARALLEL EXCHANGER BRANCHES WITH BLOCK VALVES WHICH IMPLIES THE POTENTIAL NEED TO OPERATE WITH ONLY ONE BRANCH. NO OVER-DESIGN MAY BE APPROPRIATE IN SOME CASES.

D2. FIVE LIMITING FLOW AREAS IN THREE DIMENSIONS MUST BE EVALUATED FOR INLET AND OUTLET REGIONS. EACH OF THESE FIVE AREAS MAY BE LIMITED BY EXCHANGER ENTRANCE/EXIT AREAS OR BUNDLE ENTRANCE/EXIT AREAS DEFINED BELOW.

EXCHANGER ENTRANCE/EXIT AREAS (BETWEEN NOZZLE AND IMPINGEMENT DEVICE, IF ANY, OR BUNDLE):

- AXIAL FLOW AREA IN EACH DIRECTION (TOWARDS NEAREST FLOW BAFFLE AND TOWARDS TUBE SHEET OR FULL SUPPORT PLATE).
- CIRCUMFERENTIAL FLOW AREA IN EACH DIRECTION. SEAL BARS EXTENDING INTO THE ENTRANCE/EXIT REGIONS BLOCK THIS FLOW.
- FLOW AREA WITHIN THE NOZZLE PROJECTION AREA BETWEEN IMPINGEMENT RODS, IF ANY, OR BETWEEN TUBES. IMPINGEMENT PLATES BLOCK THIS FLOW.

BUNDLE ENTRANCE/EXIT AREAS (INTO OR OUT OF THE TUBE BUNDLE BETWEEN PERIPHERAL TUBES):

- FLOW AREA BETWEEN TUBES ON EACH AXIAL SIDE OF THE NOZZLE, EXCLUDING NOZZLE PROJECTION AREA, BETWEEN THE NOZZLE AND NEAREST FLOW BAFFLE, AND BETWEEN THE TUBE SHEET OR FULL U-BEND SUPPORT PLATE.
- FLOW AREA BETWEEN TUBES ON EACH CIRCUMFERENTIAL SIDE OF THE NOZZLE, EXCLUDING NOZZLE PROJECTION AREA AND AREAS COUNTED IN THE ABOVE ITEM.
- FLOW AREA BETWEEN TUBES WITHIN THE NOZZLE PROJECTION AREA. IMPINGEMENT PLATES BLOCK THIS FLOW.

THE TOTAL ENTRANCE/EXIT AREA IS THE SUM OF THE SMALLEST AREAS FOR EACH OF THE FIVE DIRECTIONS FROM THE NOZZLE DETERMINED ABOVE. FOR EXAMPLE, IF AN IMPINGEMENT PLATE EXTENDS TO THE FIRST FLOW BAFFLE AND SEAL BARS EXTEND INTO THE ENTRANCE REGION, FLOW IN FOUR OF FIVE DIRECTIONS ARE BLOCKED AND TOTAL AREA IS THE SMALLER OF THE FLOW AREA OFF THE IMPINGEMENT PLATE TOWARDS THE TUBE SHEET OR FULL SUPPPORT PLATE AND FLOW AREA BETWEEN

## DESIGN NOTES (CON'T)

TUBES IN THE SAME DIRECTION. MORE COMMONLY, IMPINGEMENT RODS ARE USED, SEAL BARS DO NOT EXTEND INTO THE ENTRANCE REGION AND THE NEAREST FLOW BAFFLE IS FAR FROM THE NOZZLE. THEN FLOW EXISTS IN ALL FIVE DIRECTIONS. IF NOZZLE FLOW AREA IS SMALLEST, AND THE SUM OF FLOW AREAS BETWEEN THE NOZZLE AND IMPINGEMENT RODS IS A LITTLE LARGER, AND THE SUM OF FLOW AREAS INTO THE BUNDLE IS LARGEST, FLOW IS WELL DISTRIBUTED, THE NEED FOR PARTIAL TUBE SUPPORTS IS MINIMIZED AND THE LIMITING FLOW AREA IS DETERMINED BY EXCHANGER ENTRANCE GEOMETRY.

FIGURE 1 FLOW VELOCITY IS BASED OF THE COMPOSITE LIMITING AREAS FOR INLET OR OUTLET.

D3. FIGURE 2 USUALLY ONLY LIMITS L4 SPANS OF INTERIOR TUBES IN THE ROW OR COLUMN OF TUBES JUST DOWNSTREAM OF BAFFLE CUTS. IN THIS CASE FLOW AREA IS BASED ON FLOW AREA BETWEEN TUBES IN THE ROW OR COLUMN JUST DOWNSTREAM OF THE BAFFLE CUT WITH AXIAL FLOW LENGTH BASED ON THE SMALLER OF THE UPSTREAM OR DOWNSTREAM L3 DIMENSION. FIGURE 2 ALSO APPLIES TO INTERIOR TUBES IN INLET AND OUTLET REGIONS AND CAN BE EVALUATED WITH THE FLOW VELOCITY DETERMINED IN D2 ABOVE; HOWEVER, FIGURE 2 RARELY LIMITS THESE SPANS.

D4. FULL SUPPORT PLATES ARE REQUIRED AT SHELL NOZZLE CENTERLINES FOR THE CENTRAL NOZZLE OF TEMA TYPE J SHELLS AND ALL NOZZLES OF TEMA TYPE G AND H SHELLS.

SUPERSEDES GB-E1048-1

REVISIONS

| | | | | |
|---|---|---|---|---|
| 1 | CONSOLIDATED PREVIOUS CURVES AS FIG.1 ADDED FIG.2 AND ALLOWABLE SPAN MULTIPLIERS. REVISED NOTES ACCORDINGLY. 10-21-86 | KKY | MFS | WAE |
| | | FHT | CHM | |
| 2 | REVIEWED DURING MANUALS RESTRUCTURING - NO CHANGES 12-7-89 | | | |
| 3 | REWROTE GENERAL AND DESIGN NOTES. MODIFIED SECT 'A' ADDED 3 MORE MATERIALS WITH MULTIPLIERS TO 'ALLOWABLE SPAN MULTIPLIER' NOTE 3. 2-11-98 | BJS | TAV | WAE |

Chevron Research and Technology

SCALE NONE DATE 9-8-71 APPROVED

DR. ____ CH. ____ DR. APP. JHL ENGR. BLH GHH 9/23

OPR'G DEPT. ____ ENG. DEPT. ____

ALLOWABLE UNSUPPORTED TUBE LENGTHS IN SHELL AND TUBE HEAT EXCHANGERS

E W.O. ____ S.O. ____ GC-E1048-3

STANDARD DRAWING

CE1048B0.DWG 2/12/98 MDR T:\STDDWGS