UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

December 2, 1986

Docket No. 50-267

MEMORANDUM FOR: Herbert N. Berkow, Director
Standardization and Special
Projects Directorate
Division of PWR Licensing-B, NRR

THRU: Oliver D. T. Lynch, Jr., Section Leader
Standardization and Special
Projects Directorate
Division of PWR Licensing-B, NRR

FROM: Kenneth L. Heitner, Project Manager
Standardization and Special
Projects Directorate
Division of PWR Licensing-B, NRR

SUBJECT: SUMMARY OF NOVEMBER 20, 1986 MEETING WITH PUBLIC SERVICE COMPANY OF COLORADO (PSC) TO DISCUSS FORT ST. VRAIN (FSV) TEMPERATURE PROFILES FOR EQUIPMENT QUALIFICATION

This meeting was requested by PSC in response to the October 30, 1986 letter from the NRC to PSC concerning FSV temperature profiles for equipment qualification. In this letter, the NRC had concluded that the calculational methods used by PSC were not conservative. The purpose of this meeting was to review PSC's calculations and methodologies, and find a potential basis for NRC approval of the FSV temperature profiles. Attendees at this meeting are listed in Enclosure 1.

PSC presented a summary of their basis for concluding that their temperature profile calculations were conservative (see Enclosure 2). PSC stated that the different computer codes used by the staff's consultant and PSC were not the cause of the different temperature profiles. However, the lower heat transfer coefficients used by the staff's consultant were the primary cause of the differences. PSC noted the higher heat transfer coefficients that they had used were derived from original licensing calculations, and were accepted by the staff when the plant was originally licensed. PSC felt these heat transfer coefficients were still conservative.

PSC had investigated the possibility of taking credit for potential limitations in plant power level. However, preliminary calculations for scenario HRH-2 at 75 percent of full power still exceeded the design temperature profile.

PSC further noted that large conservatisms existed in the restricted volumes they had used for their evaluations in the reactor and turbine buildings. The actual building volumes were considerably higher. However, preliminary calculations with less conservative building volumes gave much lower temperature profiles. PSC maintained that the temperature profiles used for equipment qualification could not easily be modified, since most of the equipment qualification files were complete. For certain critical components, such as cables, the margin in temperature for equipment qualification was small.

The staff held a separate caucus. The staff then directed PSC to redo the sample temperature profiles with the following guidance:

- Use heat transfer coefficients similar in value to the staff's consultants (approximately one in English units),

- Use revised building volume and surface area parameters to reflect additional volumes where steam could easily penetrate, and

- Do the sample calculations for a large break (i.e., HRH-2), small break (i.e., CRH-19), and operator-isolated break. Three revised calculations should be done for each building.

The staff also recommended that PSC provide a separate evaluation of other factors which provided additional conservatisms in these calculations, such as the blowdown orifice coefficient and thermal radiation from the hot gas to colder surfaces.

PSC stated that additional time would be needed to perform these new analyses. They estimated that analyses for the first building could be submitted by mid-December 1986, and for the second building by the end of December 1986.

The staff noted that this could potentially impact the schedule for the field inspection and would advise PSC if a schedule change was needed. (Subsequent to the meeting, the staff advised PSC that the current schedule for the field inspection would be maintained).

Kenneth L. Heitner

Kenneth L. Heitner, Project Manager
Standardization and Special
Projects Directorate
Division of PWR Licensing-B, NRR

Enclosures:
As stated

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| 11/20/86 | 11/ /86 | 12/ /86 | 11/ /86 |

Enclosure 1

# FSV Temperature Profile Meeting

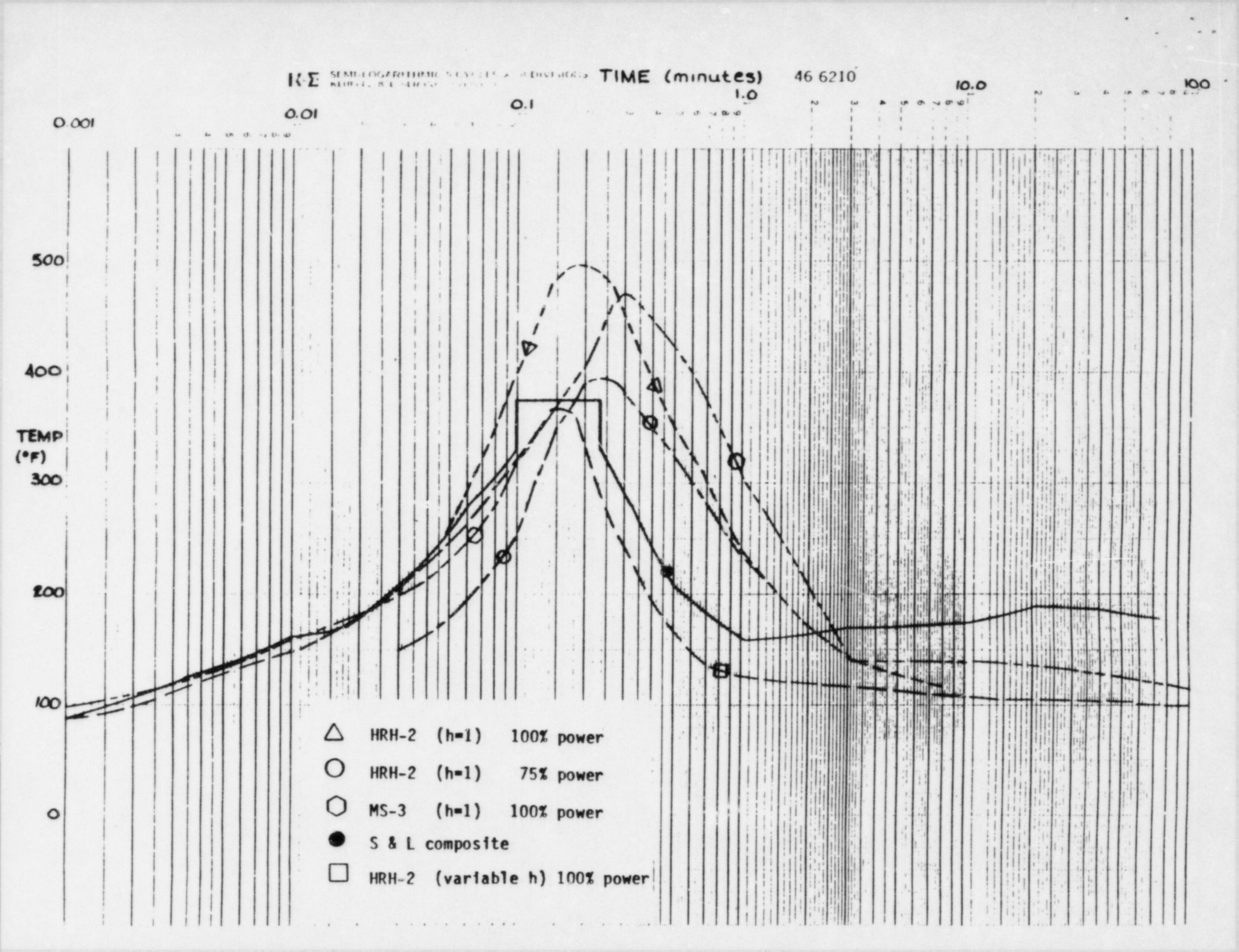
## LIST OF ATTENDEES

| Name | Affiliation |
|---|---|
| J. C. Conklin | Oak Ridge National Laboratory |
| Charles Hinson | NRC/NRR/DPLB/PBSS |
| Robert Jones | NRC/NRR/DPLB/RSB |
| J. S. Wermiel | NRC/NRR/DPLB/PEICB |
| Paul Shemanski | NRC/NRR/DPLB/PEICB |
| Jose A. Calvo | NRC/NRR/DPLB/PEICS |
| Richard E. Ireland | NRC/RIV/RSB-ES |
| K. L. Heitner | NRC/NRR/DPLB/PBSS |
| Mark White | Battelle/PNL |
| Carl Wheeler | PNL |
| Don Warembourg | PSC |
| M. L. Holmes | PSC/Nucl. Licensing |
| M. E. Niehoff | PSC/Nucl. Design Mgr. |
| Carmels Rodriquez | GA Technologies-Engineering |
| F. W. Tilson | PSC/Nucl. Engineering |
| Ken Dvorak | PSC/Nucl. Engineering |
| Art Barsell | GA Technologies |
| F. C. Dahms | GA Technologies |
| John C. McKinley | NRC/ACRS Staff |
| Julio Landoni | GA Technologies |
| Max Yost | EG&G, Idaho |
| Norman Wagner | NRC/NRR/DPLB/PEICSB |
| John Ridgely | NRC/NRR/DPLB/RSB |
| O. D. T. Lynch, Jr. | NRC/NRR/DPLB/PBSS |
| Herb Berkow | NRC/NRR/DPLB/PBSS |
| Dennis Crutchfield | NRC/NRR/DPLB |
| Chang Li | NRC/NRR/PWR-A/PSB |

# DISCUSSION ITEMS

- THE ISSUE
- HRH-2 BLOWDOWN ANALYSIS
- COMPARISON OF CVTR TEST DATA TO FSV ANALYSIS
- LITERATURE SUPPORTING PREVAILING HEAT TRANSFER COEFFICIENTS
- CONSERVATISMS IN ANALYSIS

THE ISSUE: APPROPRIATE VALUES FOR
HEAT TRANSFER COEFFICIENTS FOR
FORT ST. VRAIN STEAM LINE BREAKS


K-E
TIME (minutes)
46 6210
0.001
0.01
0.1
1.0
10.0
100
500
400
TEMP
(°F)
300
200
100
0
HRH-2 (h=1) 100% power
HRH-2 (h=1) 75% power
MS-3 (h=1) 100% power
S & L composite
HRH-2 (variable h) 100% power

# CONSERVATISMS

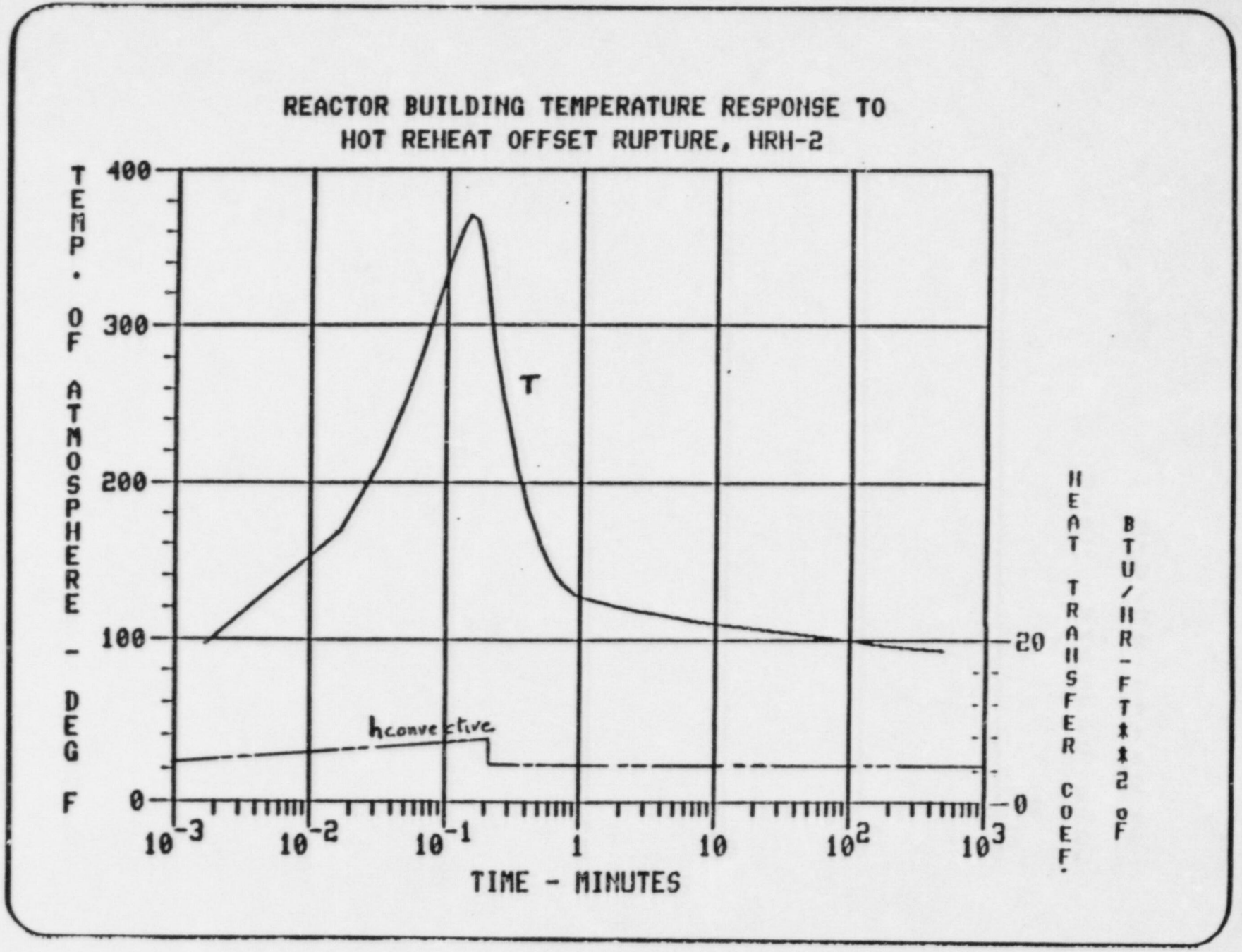
- THE UCHIDA HEAT TRANSFER COEFFICIENT UTILIZED FOR THE CONDENSING REGIME OF THE FSV BLOW-DOWN ARE RECOGNIZED AS CONSERVATIVE.
- THE CONVECTIVE HEAT TRANSFER COEFFICIENT IS CONSERVATIVE BASED ON ACTUAL TEST DATA.
- TOTAL HEAT REMOVAL IS LOW FROM GAS MIXTURE (TAGAMI CORRELATION)
- BOUNDING BLOWDOWN ORIFICE COEFFICIENT (1.0) IS CONSERVATIVE.
- VOLUMES AND HEAT SINKS UTILIZED IN DEVELOPMENT OF FSV TEMPERATURE PROFILES ARE CONSERVATIVELY LOW.

# HRH-2 BLOWDOWN ANALYSIS

- DURING BLOWDOWN
  - $H_{CONV}$ VARIES LINEARLY FROM 5 AT START TO 7.5 BTU/FT$^2$-H-°F AT END OF BLOWDOWN
  - $H_{COND}$ IS BASED ON UCHIDA
  - $H_{TOTAL}$ IS ABOUT 15 BTU/FT$^2$-H-°F AT END OF BLOWDOWN

## HRH-2 BLOWDOWN ANALYSIS (CONT)

- AFTER BLOWDOWN
  - $H_{CONV}$ IS EQUAL TO 5 BTU/FT$^2$-H-°F
  - $H_{CONV_D}$ IS BASED ON UCHIDA


REACTOR BUILDING TEMPERATURE RESPONSE TO
HOT REHEAT OFFSET RUPTURE, HRH-2
TEMP. OF ATMOSPHERE - DEG F
400
300
200
100
0
T
hconvective
20
0
HEAT TRANSFER COEF.
BTU/HR-FT**2 OF
$10^{-3}$
$10^{-2}$
$10^{-1}$
1
10
$10^{2}$
$10^{3}$
TIME - MINUTES

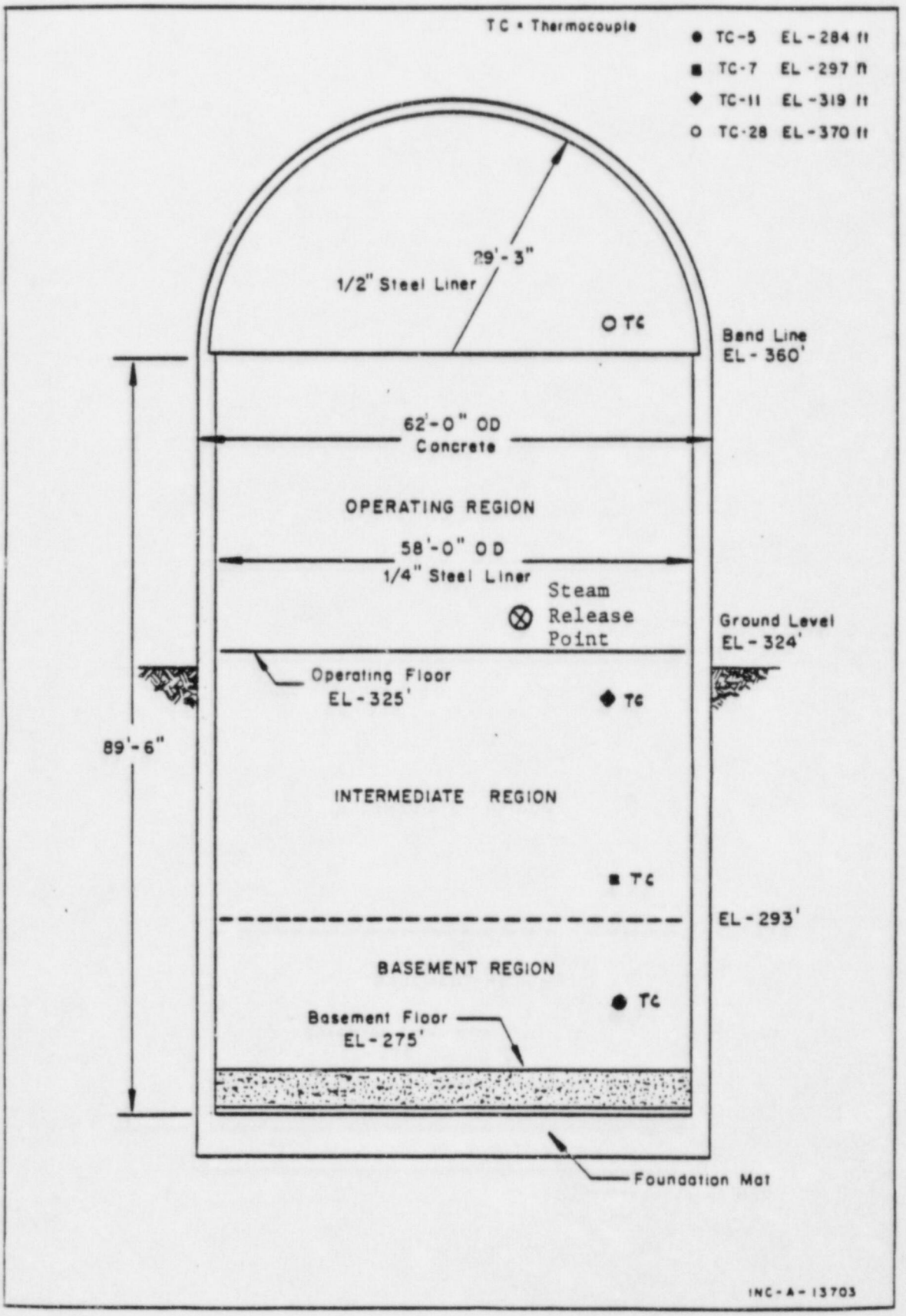



FIG. 1 CVTR CONTAINMENT STRUCTURE.

## COMPARISON OF CVTR TEST 3 WITH FSV HOT REHEAT HEADER BLOWDOWN (REACTOR BUILDING) - HRH-2

| PARAMETER | CVTR TEST 3 | HRH-2 |
|---|---|---|
| BLOWDOWN TIME, SEC. | 170 | 13 |
| TOTAL STEAM ENERGY RELEASE, BTU | $1.9 \times 10^7$ | $1.2 \times 10^7$ |
| ANALYSIS VOLUME, $FT^3$ | 227,000 | 534,730 |
| HEAT SINK AREA, $FT^2$ | 37,120 | 282,550 |
| STEAM RELEASE RATE AT 10 SEC, LB/H | $3.2 \times 10^5$ | $2.3 \times 10^6$ |
| SPECIFIC ENTHALPY AT 10 SEC, BTU/LB | 1264 | 1535 |
| TOTAL STEAM RELEASE, LB | $1.5 \times 10^4$ | $7.9 \times 10^3$ |
| PEAK GAS TEMPERATURE, °F | 209 | 371 |

# COMPARISON OF CVTR TEST DATA WITH CONTEMPT-G MODEL RESULTS

| CASE | HEAT TRANSFER COEFF.* BTU/FT$^2$-H-°F CONVECTION | CONDENSATION | TOTAL VOLUME PEAK PRESSURE PSIG | PEAK TEMPERATURE °F |
|---|---|---|---|---|
| CONTEMPT-G MODEL RUNS | | | | |
| 1 | 2 | UCHIDA | 27.3 | 361 |
| 2 | 5 | UCHIDA | 23.5 | 281 |
| 3 | 10 | UCHIDA | 20.9 | 224 |
| 4 | 20 | UCHIDA | 19.4 | 215 |
| 5 | 20 | 2 x UCHIDA | 16.5 | 209 |
| CVTR TEST 3 DATA+ | | | 18.0 | 209 |

* DURING BLOWDOWN

\+ TEST 4 AND 5 CONDITIONS AND BLOWDOWN RESULTS WERE SIMILAR

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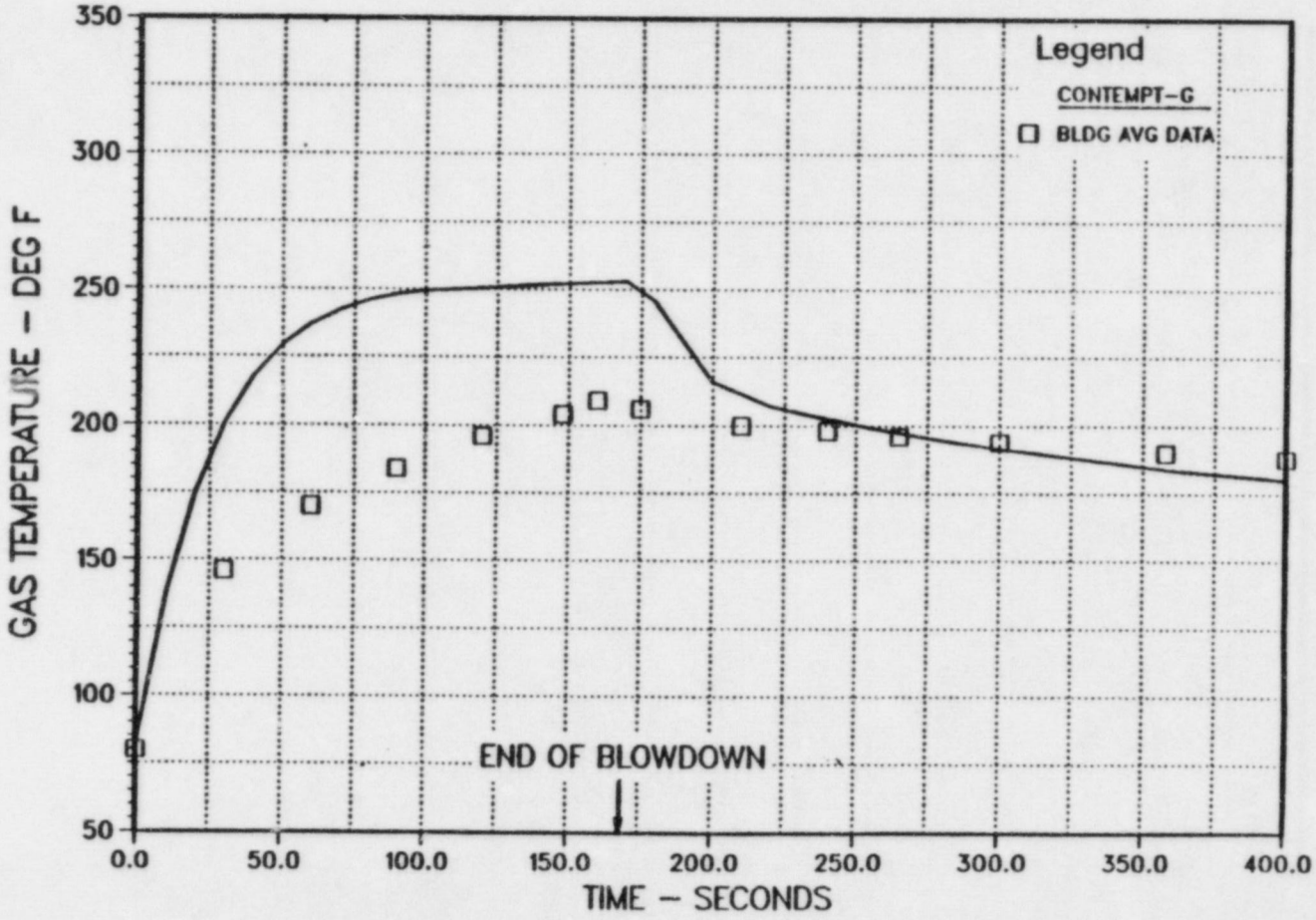
# COMPARISON OF CVTR TEST TEMPERATURE DATA WITH CONTEMPT–G TOTAL VOLUME MODEL

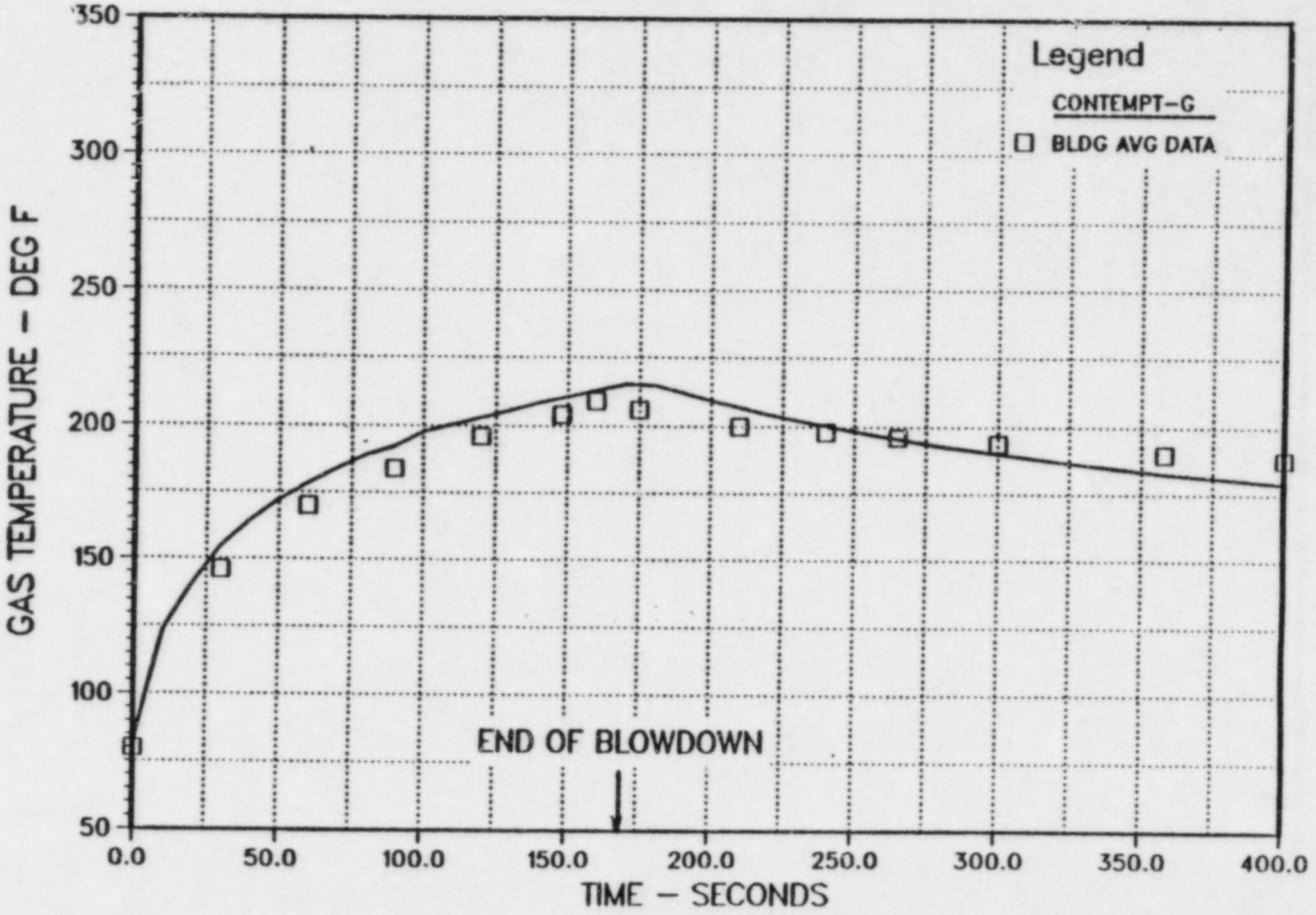



ST1215 11/15/86

$h_{conv}$ = 5 TO 7.5/5 DURING/AFTER BLOWDOWN; UCHIDA CONDENSATION

GA Technologies

# COMPARISON OF CVTR TEST TEMPERATURE DATA WITH CONTEMPT–G TOTAL VOLUME MODEL




ST9760 11/13/86

$h_{conv}$ = 20/5 DURING/AFTER BLOWDOWN; UCHIDA CONDENSATION

## LITERATURE SUPPORTING PREVAILING HEAT TRANSFER COEFFICIENTS BY CONVECTION (HTCV) DURING STEAM BLOWDOWNS

- SLAUGHTERBECK'S RECOMMENDATION FOR AN INITIAL HTCV IS 5 BTU/($FT^2$-H-°F)
- BENHAM, ET AL, ADOPTED SLAUGHTERBECK'S RECOMMENDATION FOR PREVIOUS FSV EQ WORK
- ALMENAS'S METHODOLOGY BASED ON MATCHING CVTR, LEADS TO HTCV OF ABOUT 10 BTU/($FT^2$-H-°F)
- FRANK, ET AL, METHODOLOGY, BASED ON MATCHING CVTR, GENERATES AN ALL CONVECTIVE HTCV OF 20 BTU/($FT^2$-H-°F)
- JUBB'S METHODOLOGY BASED ON BOILER LEAK TESTS LEADS TO AN HTCV OF 5 BTU/($FT^2$-H-°F)

## CONSERVATISMS IN ANALYSIS

1. RELATIVE TO CVTR, CONVECTIVE HEAT TRANSFER COEFFICIENT IS CONSERVATIVE BY FACTOR OF 3.

## CONSERVATISMS IN ANALYSIS (CONT)

2. RELATIVE TO TAGAMI, HEAT REMOVAL FROM ATMOSPHERE IS CONSERVATIVE BY A FACTOR OF 4.

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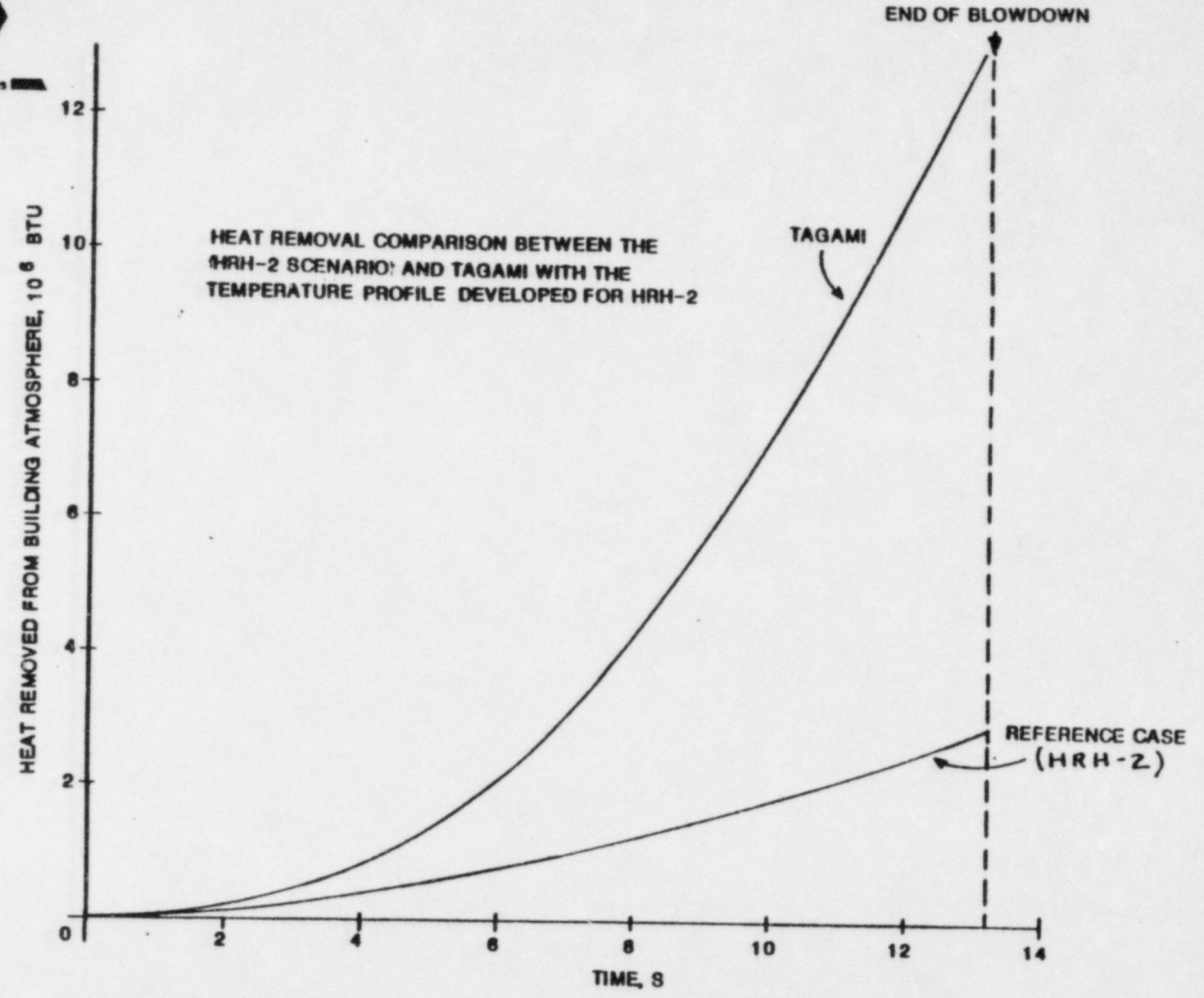

## CONSERVATISMS IN ANALYSIS (CONT)

3. ALL BLOWDOWNS ASSUMED TO EXIT PIPES WITH AN EFFECTIVE FLOW ORIFICE COEFFICIENT OF 1.0.

# CONSERVATISMS IN ANALYSIS (CONT)

4. VOLUMES AND HEAT SINK AREAS UTILIZED IN THE CONTEMPT-G CALCULATIONS ARE CONSERVATIVELY LOW.

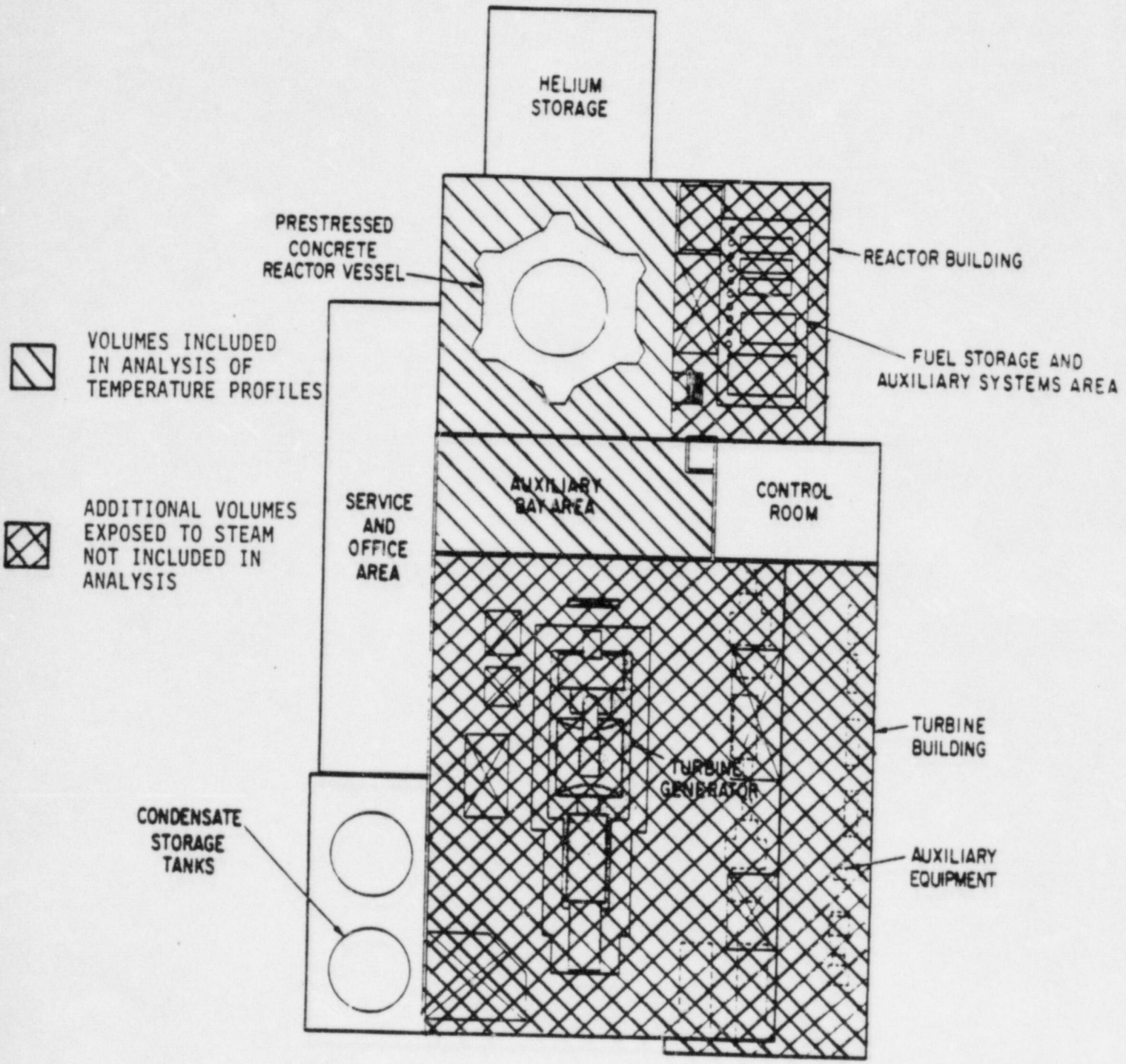


Figure 1.2-2 Plan View of Reactor Building and Turbine Building

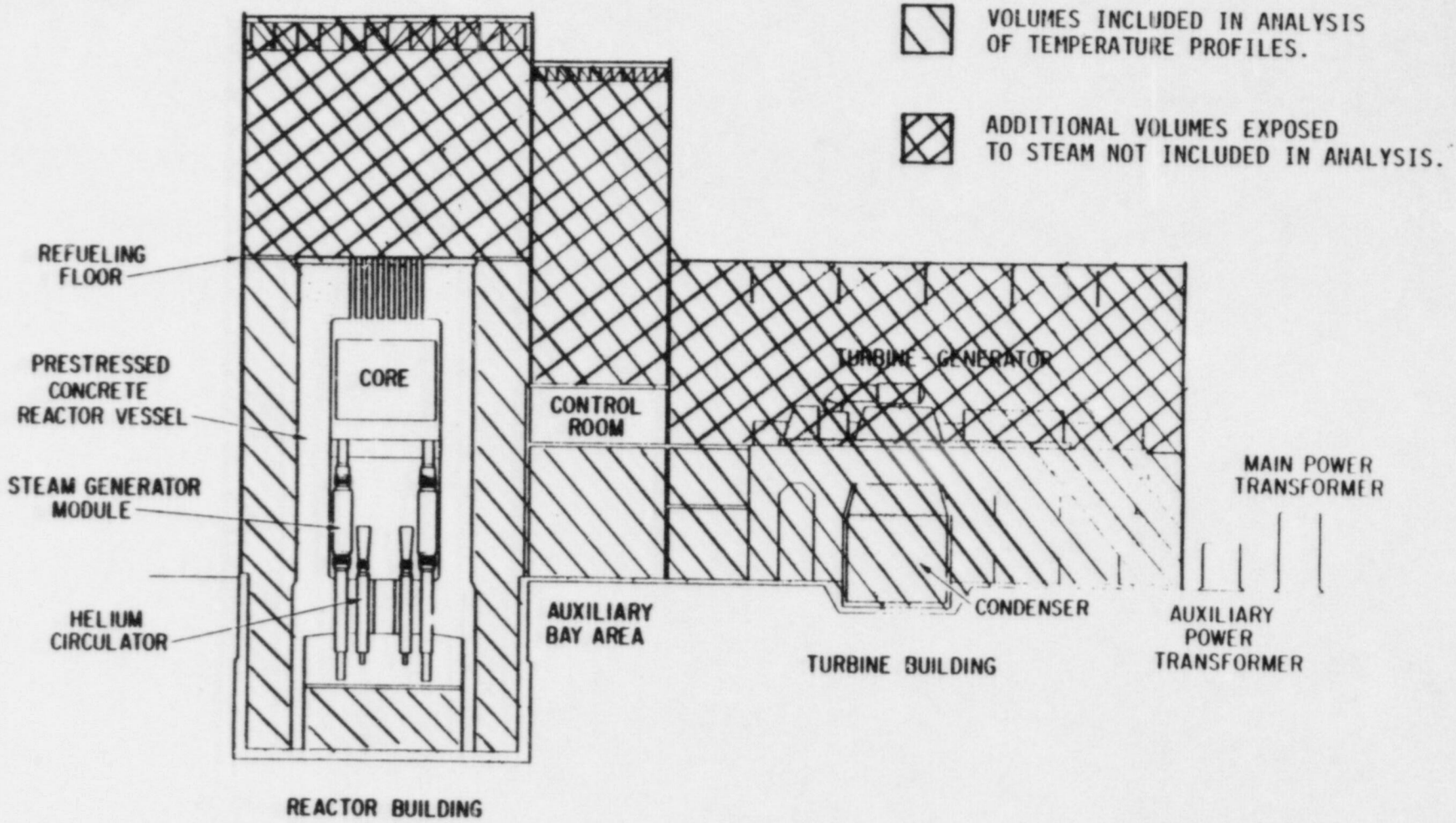


Figure 1.2-3 Section Through Reactor Building and Turbine Building

REACTOR BUILDING

SURFACE AREAS AND VOLUMES

| | Area $ft^2$ | Volume $ft^3$ |
|---|---|---|
| * Around PCRV | 282,550 | 534,730 |
| Region east of 4A wall | 157,470 | 327,310 |
| Above Refueling floor | 68,420 | 711,160 |

TURBINE BUILDING

SURFACE AREAS AND VOLUMES

| | Area $ft^2$ | Volume $ft^3$ |
|---|---|---|
| * Below Operating floor | 296,990 | 750,000 |
| Above Operating floor | 68,780 | 920,000 |
| Aux. Bay Area | Not calculated | Not calculated |

\- - -

* Used in CONTEMPT-G profile calculation

# CONCLUSIONS

1. HEAT TRANSFER COEFFICIENTS USED ARE CONSERVATIVE.

2. ANALYTICAL APPROACH HAS OTHER MAJOR CONSERVATISMS IN ADDITION TO HTC CONSERVATISMS.

3. COMPOSITE TEMPERATURE PROFILE IS CONSERVATIVE AND APPROPRIATE FOR FORT ST. VRAIN EQUIPMENT QUALIFICATION.

Mr. R. O. Williams
Public Service Company of Colorado

Fort St. Vrain

cc:
Mr. D. W. Warembourg, Manager
Nuclear Engineering Division
Public Service Company
of Colorado
P. O. Box 840
Denver, Colorado 80201

Mr. David Alberstein, 14/159A
GA Technologies, Inc.
Post Office Box 85608
San Diego, California 92138

Mr. H. L. Brey, Manager
Nuclear Licensing and Fuel Division
Public Service Company of Colorado
P. O. Box 840
Denver, Colorado 80201

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O.Box 840
Platteville, Colorado 80651

Kelley, Stansfield & O'Donnell
Public Service Company Building
Room 900
550 15th Street
Denver, Colorado 80202

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Chairman, Board of County Commissioners
of Weld County, Colorado
Greeley, Colorado 80631

Regional Representative
Radiation Programs
Environmental Protection Agency
1 Denver Place
999 18th Street, Suite 1300
Denver, Colorado 80202-2413

Albert J. Hazle, Director
Radiation Control Division
Department of Health
4210 East 11th Avenue
Denver, Colorado 80220

Mr. J. W. Gahm, Manager
Nuclear Production Division
Public Service Company of Colorado
16805 Weld County Road 19-1/2
Platteville, Colorado 80651

Mr. P. F. Tomlinson, Manager
Quality Assurance Division
Public Service Company of Colorado
16805 Weld County Road 19-1/2
Platteville, Colorado 80651

Mr. R. F. Walker
Public Service Company of Colorado
Post Office Box 840
Denver, Colorado 92138

Commitment Control Program
Coordinator
Public Service Company of Colorado
2420 W. 26th Ave. Suite 100-D
Denver, Colorado 80211