2. To: (Receiving Organization) TWR/ENG	3. From: (Originating Organization) Consequence Analysis 8M400	4. Related EDT No.: NA
5. Proj./Prog./Dept./Div.: TWRS FSAR	6. Cog. Engr.: J. C. Van Keuren N2134	7. Purchase Order No.: NA
8. Originator Remarks: <div style="text-align: center; font-size: 1.2em; margin-top: 20px;">For Release</div>		9. Equip./Component No.: NA
11. Receiver Remarks:		10. System/Bldg./Facility: TWRS TANK FARMS
		12. Major Assm. Dwg. No.: NA
		13. Permit/Permit Application No.: NA
		14. Required Response Date: June 14, 1996

15. DATA TRANSMITTED					(F)	(G)	(H)	(I)
(A) Item No.	(B) Document/Drawing No.	(C) Sheet No.	(D) Rev. No.	(E) Title or Description of Data Transmitted	Approval Designator	Reason for Transmittal	Originator Disposition	Receiver Disposition
1	WHC-SD-WM-CN-035	—	0	200 AREA POPULATION WEIGHTED X/Q FOR THE PUBLIC WITHIN 10 MILES OF THE SITE BOUNDARY	N/A	1	1	1

16. KEY									
Approval Designator (F)		Reason for Transmittal (G)				Disposition (H) & (I)			
E, S, Q, D or N/A (see WHC-CM-3-5, Sec. 12.7)		1. Approval		4. Review		1. Approved		4. Reviewed no/comment	
		2. Release		5. Post-Review		2. Approved w/comment		5. Reviewed w/comment	
		3. Information		6. Dist. (Receipt Acknow. Required)		3. Disapproved w/comment		6. Receipt acknowledged	
17. SIGNATURE/DISTRIBUTION (See Approval Designator for required signatures)									
(G)	(H)	(J) Name	(K) Signature	(L) Date	(M) MSIN	(J) Name	(K) Signature	(L) Date	(M) MSIN
Reason	Disp.								
1	1	Cog. Eng. J. C. Van Keuren	<i>[Signature]</i>	6/14/96	AD-34				
1	1	Cog. Mgr. D. S. Leach	<i>[Signature]</i>	6/14/96					
		QA							
		Safety							
		Env.							
1	1	Peer Reviewer B. E. Hey	<i>[Signature]</i>	6/14/96					
18. <i>[Signature]</i> J. C. Van Keuren Signature of EDT Originator		19. <i>[Signature]</i> Authorized Representative Date for Receiving Organization				20. <i>[Signature]</i> D. S. Leach Cognizant Manager Date			
21. DOE APPROVAL (if required) Ctrl. No. ☐ Approved ☐ Approved w/comments ☐ Disapproved w/comments									

200 AREA POPULATION WEIGHTED X/Q FOR THE PUBLIC WITHIN 10 MILES OF THE SITE BOUNDARY

J. C. Van Keuren

Westinghouse Hanford Co, Richland, WA 99352

U.S. Department of Energy Contract DE-AC06-87RL10930

EDT/ECN: 156477

UC: 630

Org Code: 8M400

Charge Code: N2134

B&R Code: EW3135090

Total Pages: 15

Key Words: X/Q, Tank Farms, Population

Abstract: An overall population weighted atmospheric dispersion coefficient (X/Q) has been calculated for the public within 10 miles of the Hanford Site boundary. The Columbia river was assumed as the Hanford site boundary to the north and the east. The GXQ code was used for the calculation. The value calculated is 1.88×10^{-8} s/m³.

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J. Mahan
Release Approval

7/9/96
Date

Approved for Public Release

A calculation of the population weighted atmospheric dispersion coefficients (X/Qs) based on the public located within a 10 mile radius of the Hanford site boundary was performed. The values will be used for comparison with the DOE risk guidelines. The calculation was performed with the GXQ code (Hey 1993) with the following assumptions:

1. The release point was assumed to be the 200 area tank farms. The minimum distances to the site boundary were based on the calculations for the TWRS FSAR (SARR-016). Ten miles (16,090 m) was added to the distance to determine an area in which population is located. The Columbia river was used as the site boundary to the north and the east.
2. A X/Q averaged over all 16 sector was calculated. The X/Q is population weighted based on population distribution data for the population within 16.1 km (10 miles) of the site boundary. The X/Q reported is for an average individual within this area. Sector averaging was used to determine a X/Q based on the population being spread across the sector.
3. The X/Q is based on annual average meteorology. Population data are based on 1990 census. Meteorology conditions are calculated based on joint frequency data from 1983 to 1990.

The distances to the site boundary, and the distance plus 10 miles, and the population in each sector are shown in Table 1. The population weighted peak X/Q for the average individual averaged over all 16 sectors is 1.88 E-08. The GXQ input and output files are attached.

References

- Hey, B. E., 1993, *GXQ Program Users' Guide*, WHC-SD-GN-SWD-30002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.
- SARR-016, 1996, *Tank Waste Compositions and Atmospheric Dispersions Coefficients for Use in Safety Analysis Consequence Assessments*, WHC-SD-WM-SARR-016, Rev. 2, Draft, Westinghouse Hanford Company, Richland, Washington.

Table 1 Distances and Populations

TRANSPORT DIRECTION	DISTANCE TO SITE BOUNDARY (m)	DISTANCE TO SITE BOUNDARY PLUS 10 MILES (m)	POPULATION WITHIN 10 MILES OF HANFORD SITE BOUNDARY
S	15360	31450	2842
SSW	15640	31730	713
SW	13875	29965	1308
WSW	11100	27190	1956
W	11100	27190	771
WNW	11100	27190	641
NW	11440	27530	548
NNW	8690	24780	544
N	8760	24850	434
NNE	10610	26700	268
NE	10680	26770	393
ENE	10530	26620	423
E	12630	28720	452
ESE	18730	34820	289
SE	22440	38530	1141
SSE	19960	36050	2796

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Attachment 1 GXQ Input File

```

Population based on 1 mile from river bd annual average meteorology
c GXQ Version 4.0 Input File
c mode
  1
c
c MODE CHOICE:
c mode = 1 then X/Q based on Hanford site specific meteorology
c mode = 2 then X/Q based on atmospheric stability class and wind speed
c mode = 3 then X/Q plot file is created
c
c LOGICAL CHOICES:
c   ifox  inorm icdf  ichk  isite ipop
c   f     f     f     f     t     t
c ifox = t then joint frequency used to compute frequency to exceed X/Q
c       = f then joint frequency used to compute annual average X/Q
c inorm = t then joint frequency data is normalized (as in GENII)
c       = f then joint frequency data is un-normalized
c icdf  = t then cumulative distribution file created (CDF.OUT)
c       = f then no cumulative distribution file created
c ichk  = t then X/Q parameter print option turned on
c       = f then no parameter print
c isite = t then X/Q based on joint frequency data for all 16 sectors
c       = f then X/Q based on joint frequency data of individual sectors
c ipop  = t then X/Q is population weighted
c       = f then no population weighting
c
c X/Q AND WIND SPEED ADJUSTMENT MODELS:
c   ipuff idep isrc iwind
c   0     0   0   0
c DIFFUSION COEFFICIENT ADJUSTMENT MODELS:
c   iwake ipm iflow ientr
c   0     3   0   0
c EFFECTIVE RELEASE HEIGHT ADJUSTMENT MODELS:
c   (irise igrnd)iwash igrav
c   0     0   0   0
c ipuff = 1 then X/Q calculated using puff model
c       = 0 then X/Q calculated using default continuous plume model
c idep  = 1 then plume depletion model turned on (Chamberlain model)
c isrc  = 1 then X/Q multiplied by scalar
c       = 2 then X/Q adjusted by wind speed function
c iwind = 1 then wind speed corrected for plume height
c iwake = 1 then NRC RG 1.145 building wake model turned on
c       = 2 then MACCS virtual distance building wake model turned on
c ipm   = 1 then NRC RG 1.145 plume meander model turned on
c       = 2 then 5th Power Law plume meander model turned on
c       = 3 then sector average model turned on
c iflow = 1 then sigmas adjusted for volume flow rate
c ientr = 1 then method of Pasquill used to account for entrainment
c irise = 1 then MACCS buoyant plume rise model turned on
c       = 2 then ISC2 momentum/buoyancy plume rise model turned on

```

```

c igrnd = 1 then Mills buoyant plume rise modification for ground effects
c iwash = 1 then stack downwash model turned on
c igrav = 1 then gravitational settling model turned on
c      = 0 unless specified otherwise, 0 turns model off

```

PARAMETER INPUT:

release height hs(m)	reference anemometer height ha(m)	mixing height hm(m)	frequency to exceed Cx(%)	
0	10	1000	50.0	
initial plume width Wb(m)	initial plume height Hb(m)	release duration trd(hr)	deposition velocity vd(m/s)	gravitational settling velocity vg(m/s)
0	0	0	0.001	0.001
ambient temperature Tamb(C)	initial plume temperature T0(C)	initial plume flow rate V0(m3/s)	release diameter d(m)	convective heat release rate(l) qh(w)
20	22	1	1	0

(1) If zero then buoyant flux based on plume/ambient temperature difference.

X/Q scaling factor c(?)	Wind Speed Exponent a(?)
1.00	.78

RECEPTOR DEPENDENT DATA (no line limit)

```

c FOR MODE make RECEPTOR DEPENDENT DATA
c 1 (site specific) sector distance receptor-height
c 2 (by class & wind speed) class windspeed distance offset receptor-height
c 3 (create plot file) class windspeed xmax imax ymax jmax xmin power

```

RECEPTOR PARAMETER DESCRIPTION

```

c sector = 0, 1, 2... (all, S, SSW, etc.)
c distance = receptor distance (m)
c receptor height = height of receptor (m)
c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
c windspeed = anemometer wind speed (m/s)
c offset = offset from plume centerline (m)
c xmax = maximum distance to plot or calculate to (m)

```

```

c imax = distance intervals
c ymax = maximum offset to plot (m)
c jmax = offset intervals
c xqmin = minimum scaled X/Q to calculate
c power = exponent in power function step size
1  31450  0
2  31730  0
3  29965  0
4  27190  0
5  27190  0
6  27190  0
7  27530  0
8  24780  0
9  24850  0
10 26700  0
11 26770  0
12 26620  0
13 28720  0
14 34820  0
15 38530  0
16 36050  0

```


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Attachment 2 GXQ Output

Current Input File Name: ragpop.IN

GXQ Version 4.0
December 19, 1994

General Purpose Atmospheric Dispersion Code
Produced by Westinghouse Hanford Company

Users Guide documented in WHC-SD-GN-SWD-30002 Rev. 1.

Validation documented in WHC-SD-GN-SWD-30003 Rev. 1.

Code Custodian is: Brit E. Hey

Westinghouse Hanford Company

P.O. Box 1970

Richland, WA 99352

(509) 376-2921

Run Date = 06/12/96

Run Time = 08:15:22.87

INPUT ECHO:

Population based on 1 mile from river bd annual average meteorology

c GXQ Version 4.0 Input File

c mode

1

c

c MODE CHOICE:

c mode = 1 then X/Q based on Hanford site specific meteorology

c mode = 2 then X/Q based on atmospheric stability class and wind speed

c mode = 3 then X/Q plot file is created

c

c LOGICAL CHOICES:

c ifox inorm icdf ichk isite ipop

F F F F T T

c ifox = t then joint frequency used to compute frequency to exceed X/Q

c = f then joint frequency used to compute annual average X/Q

c inorm = t then joint frequency data is normalized (as in GENII)

c = f then joint frequency data is un-normalized

c icdf = t then cumulative distribution file created (CDF.OUT)

c = f then no cumulative distribution file created

c ichk = t then X/Q parameter print option turned on

c = f then no parameter print

c isite = t then X/Q based on joint frequency data for all 16 sectors

c = f then X/Q based on joint frequency data of individual sectors

c ipop = t then X/Q is population weighted

```

c      = f then no population weighting
c
c X/Q AND WIND SPEED ADJUSTMENT MODELS:
c  ipuff idep isrc iwind
c    0    0    0    0
c DIFFUSION COEFFICIENT ADJUSTMENT MODELS:
c  iwake ipm iflow ientr
c    0    3    0    0
c EFFECTIVE RELEASE HEIGHT ADJUSTMENT MODELS:
c  (irise igrnd)iwash igrav
c    0    0    0    0
c ipuff = 1 then X/Q calculated using puff model
c      = 0 then X/Q calculated using default continuous plume model
c idep = 1 then plume depletion model turned on (Chamberlain model)
c isrc = 1 then X/Q multiplied by scalar
c      = 2 then X/Q adjusted by wind speed function
c iwind = 1 then wind speed corrected for plume height
c iwake = 1 then NRC RG 1.145 building wake model turned on
c      = 2 then MACCS virtual distance building wake model turned on
c ipm = 1 then NRC RG 1.145 plume meander model turned on
c      = 2 then 5th Power Law plume meander model turned on
c      = 3 then sector average model turned on
c iflow = 1 then sigmas adjusted for volume flow rate
c ientr = 1 then method of Pasquill used to account for entrainment
c irise = 1 then MACCS buoyant plume rise model turned on
c      = 2 then ISC2 momentum/buoyancy plume rise model turned on
c igrnd = 1 then Mills buoyant plume rise modification for ground effects
c iwash = 1 then stack downwash model turned on
c igrav = 1 then gravitational settling model turned on
c      = 0 unless specified otherwise, 0 turns model off
c
c PARAMETER INPUT:
c
c      release      reference      frequency
c      height      anemometer      to
c      hs(m)       height          exceed
c                   ha(m)          Cx(%)
c
c      0.00000E+00  1.00000E+01  1.00000E+03  5.00000E+01
c
c      initial      initial      release      deposition      gravitational
c      plume        plume        duration     velocity        settling
c      width        height       trd(hr)      velocity        velocity
c      Wb(m)        Hb(m)         (m/s)       vg(m/s)
c
c      0.00000E+00  0.00000E+00  0.00000E+00  1.00000E-03  1.00000E-03
c
c      ambient      initial      initial      release      convective
c      temperature  plume        plume        diameter    heat release
c      Tamb(C)      TO(C)        flow rate   d(m)         rate(1)
c                   V0(m3/s)
c                   qh(w)

```

```

c      2.00000E+01    2.20000E+01    1.00000E+00    1.00000E+00    0.00000E+00
c
c (1) If zero then buoyant flux based on plume/ambient temperature difference.
c
c      X/Q            Wind
c      scaling        Speed
c      factor          Exponent
c      c(?)           a(?)
c
c      1.00000E+00    7.80000E-01
c
c RECEPTOR DEPENDENT DATA (no line limit)
c FOR MODE      make      RECEPTOR DEPENDENT DATA
c 1 (site specific)      sector distance receptor-height
c 2 (by class & wind speed) class windspeed distance offset receptor-height
c 3 (create plot file)   class windspeed xmax imax ymax jmax xqmin power
c
c RECEPTOR PARAMETER DESCRIPTION
c sector = 0, 1, 2... (all, S, SSW, etc.)
c distance = receptor distance (m)
c receptor height = height of receptor (m)
c class = 1, 2, 3, 4, 5, 6, 7 (P-G stability class A, B, C, D, E, F, G)
c windspeed = anemometer wind speed (m/s)
c offset = offset from plume centerline (m)
c xmax = maximum distance to plot or calculate to (m)
c imax = distance intervals
c ymax = maximum offset to plot (m)
c jmax = offset intervals
c xqmin = minimum scaled X/Q to calculate
c power = exponent in power function step size

```

MODE:

Site specific X/Q calculated.

LOGICAL CHOICES:

Joint frequency used to calculate annual average X/Q.

No normalization of joint frequency.

X/Q calculated for overall site.

X/Q is population weighted.

MODELS SELECTED:

Sector average model selected.

Default Gaussian plume model selected.

WARNING/ERROR MESSAGES:

JOINT FREQUENCY DATA:

200 AREA (HMS) - 10 M - Pasquill A - G (1983 - 1991 Average)

Created 8/26/92 KR

POPULATION DATA:

Population within 80 km of the Hanford 200 Area, 1990 Census (Beck, et al 1991)
 Created 10/21/91 KR, Revised 2/4/92 KR

Population based on 1 mile from river bd annual average meteorology

SECTOR	DISTANCE (m)	RECEPT HEIGHT (m)	SECT. FREQ. (%)	POPULATION	TOTAL POPULATION SCALED X/Q (s/m3)	AVERAGE INDIVIDUAL SCALED X/Q (s/m3)	ATM. STAB. CLASS	WIND SPEED (m/s)
ALL	36050	0	99.94	15519	2.92E-04	1.88E-08		

Attachment 3 PEER/HEDOP REVIEW CHECKLISTS

PEER REVIEW CHECKLIST

Document Reviewed: 200 Area Population Weighted X/Q for the Public Within 10 Miles
of the Site Boundary, WHC-SD-WM-CN-035
Author: J. C. Van Keuren
Date: 6/14/96
Scope of Review: Entire Document

Yes No NA
[] [] [x]

Previous reviews complete and cover analysis, up to scope of this review, with no gaps.

[x] [] []

Problem completely defined.

[] [] [x]

Accident scenarios developed in a clear and logical manner.

[x] [] []

Necessary assumptions explicitly stated and supported.

[x] [] []

Computer codes and data files documented.

[x] [] []

Data used in calculations explicitly stated in document.

[x] [] []

Data checked for consistency with original source information as applicable.

[] [] [x]

Mathematical derivations checked including dimensional consistency of results.

[x] [] []

Models appropriate and used within range of validity or use outside range of established validity justified.

[] [] [x]

Hand calculations checked for errors. Spreadsheet results should be treated exactly the same as hand calculations.

[x] [] []

Software input correct and consistent with document reviewed.

[x] [] []

Software output consistent with input and with results reported in document reviewed.

[] [] [x]

Limits/criteria/guidelines applied to analysis results are appropriate and referenced. Limits/criteria/guidelines checked against references.

[] [] [x]

Safety margins consistent with good engineering practices.

[] [] [x]

Conclusions consistent with analytical results and applicable limits.

[x] [] []

Results and conclusions address all points required in the problem statement.

[] [] [x]

Format consistent with appropriate NRC Regulatory Guide or other standards

[] [] [x]

Review calculations, comments, and/or notes are attached.

[x] [] []

Document approved.

Reviewer (Printed Name and Signature)

Date

HEDOP REVIEW CHECKLIST

Document Reviewed: 200 Area Population Weighted X/Q for the Public Within 10 Miles of the Site Boundary, WHC-SD-WM-CN-035
 Author: J. C. Van Keuren
 Date: 6/14/96
 Scope of Review: Entire Document

YES NO* N/A

☐	☐	☒	1. A detailed technical review and approval of the environmental transport and dose calculation portion of the analysis has been performed and documented.
☒	☐	☐	2. Detailed technical review(s) and approval(s) of scenario and release determinations have been performed and documented.
☐	☐	☒	3. HEDOP-approved code(s) were used.
☐	☐	☒	4. Receptor locations were selected according to HEDOP recommendations.
☐	☐	☒	5. All applicable environmental pathways and code options were included and are appropriate for the calculations.
☒	☐	☐	6. Hanford site data were used.
☐	☐	☒	7. Model adjustments external to the computer program were justified and performed correctly.
☐	☐	☒	8. The analysis is consistent with HEDOP recommendations.
☐	☐	☒	9. Supporting notes, calculations, comments, comment resolutions, or other information is attached. (Use the "Page 1 of X" page numbering format and sign and date each added page.)
☒	☐		10. Approval is granted on behalf of the Hanford Environmental Dose Overview Panel.

* All "NO" responses must be explained and use of nonstandard methods justified.

TSr + Hey He 6/17/96
 HEDOP-Approved Reviewer (Printed Name and Signature) Date

COMMENTS (add additional signed and dated pages if necessary):

DISTRIBUTION SHEET

To Distribution	From Consequence Analysis	Page 1 of 1
		Date July 8, 1996
Project Title/Work Order 200 Area Population Weighted X/Q for the Public Within 10 Miles of the Site Boundary		EDT No. 156477
		ECN No.

Name	MSIN	Text With All Attach.	Text Only	Attach./ Appendix Only	EDT/ECN Only
B. E. Hey	A3-34	X			
D. S. Leach	A3-34	X			
E. J. Lipke	A2-34	X			
J. C. Van Keuren	A3-34	X			
Central Files <i>original + 1 A3-88</i>	A3-98	X			