AERflare Rollout

Flare Air Dispersion Modelling Spreadsheet

15 Jan 2014
PTAC – Alberta Upstream Petroleum Research Fund
&
Alberta Energy Regulator

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and Mike Zelensky. M.Sc., P.Eng., AER

Acknowledgements

- Funding for updates and components of the AERflare and ABflare tool:
  - PTAC-Alberta Upstream Petroleum Research Fund (AUPRF)
  - Alberta Energy Regulator
  - Suncor

- AERflare tool (formerly ERCBflare)
  - Developed by M.Zelensky & Zelt PSI
- AERincin tool (formerly ERCBincin)
  - Developed by M.Zelensky & Zelt PSI
- ABflare tool
  - Developed by Zelt PSI, M.Zelensky and Exponent

AER D060 – Rollout

- AER D060 will be released soon
  - Download at WWW.aer.ca/rules-and-regulations/directives/directive-060
  - Effective 60 days after release
- AERflare Training
  - To address concerns about the changes in technical expertise, training courses will be offered

- AERflare Bug fix releases
  - As more people begin using the tools, bug reports will be inevitable, and updates will be posted as required

User Guidance Docs

- AER D060: Upstream Petroleum Industry Flaring, Incinerating, and Venting (release has been delayed)
- AESRD Non-Routine Flaring Management: Modelling Guidance (watch website for final version)
  (Draft http://environment.gov.ab.ca/info/library/8848.pdf)
- CAPP Sour Non-routine Flaring Framework (available)
  http://membernet.capp.ca/raw.asp?x=1&dt=PDF&dn=237189
- AERflare tool and User Guide (waiting for approval to post)
- ABflare tool and User Guide (waiting for approval to post)
- Classroom Training ...

ERCBflare Technical Changes

- Conversion efficiency calculations tweaks
- Hour-by-Hour assessment
- Optional Risk Based Criteria
- Blowdown calculations
- AERSCREEN & AERMOD
- AERSURFACE & AERMET
- Consistency between screening to refined analysis for non-routine and routine flaring assessments

AERflare Screening Tool v2.0

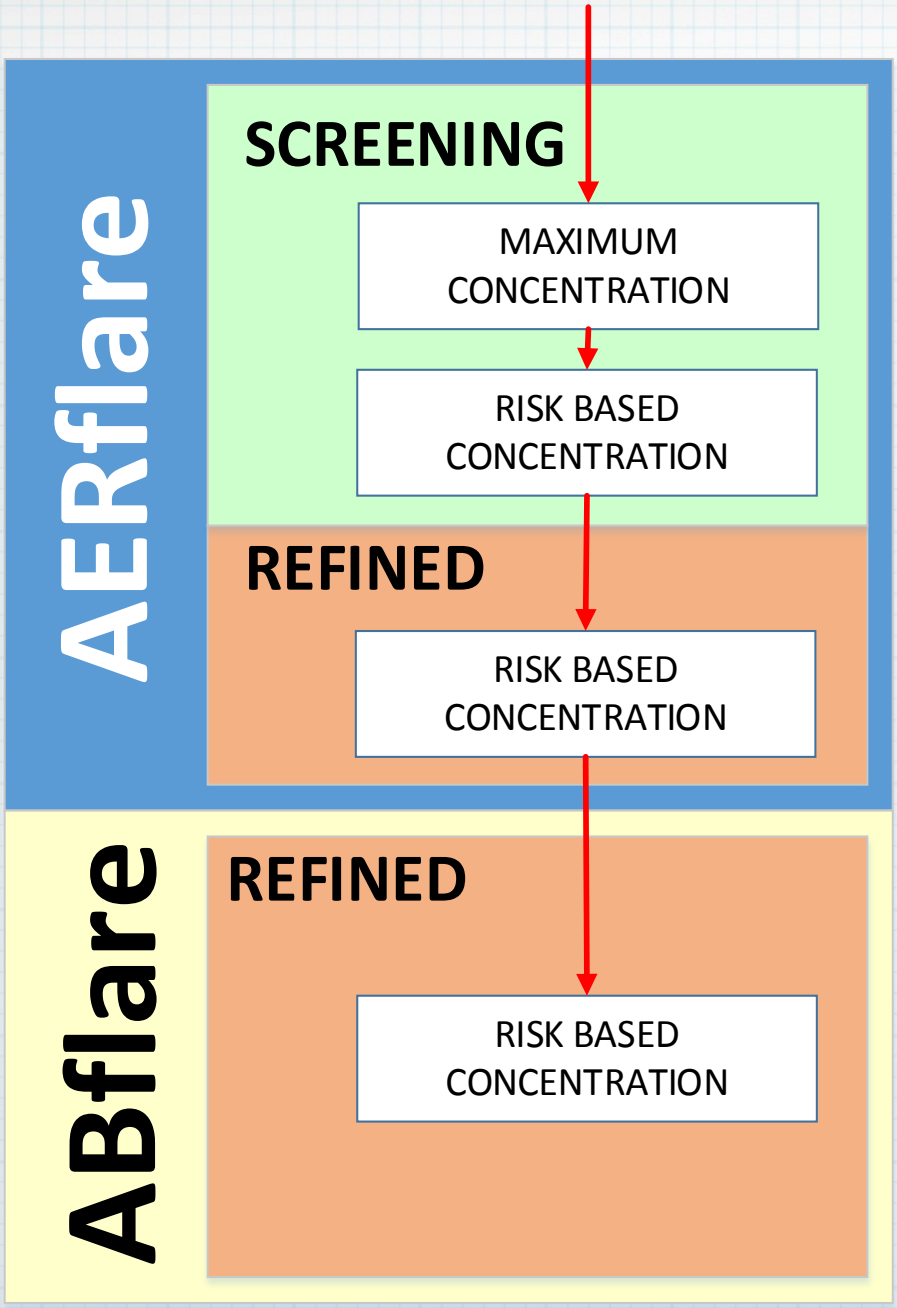
- Updated the source model consistent with ABflare and other requested features (lift gas, steam/air assist)
- AERMOD screening using AERSCREEN methods:
  - Matrix like meteorology (i.e., not real nor site specific)
  - Land use based upon simplified 8-catagories for AB then increased to BC and SK
  - User required to manually input worst case terrain

AERflare... v2.01

- More automation and less user manual input
- Automated terrain processing
  - For worst case terrain
  - For receptor grid creation for site specific
- Automated land-use processing
  - Creates a site specific meteorological data file
- Refined modelling using full AERMOD setup
- Model routine and non-routine, continuous or blowdown flaring

AERflare... v2.01

- Post-processing of external data
- Batch processing for advanced users
- Advanced switch settings
- Graphics for error checking and assessment
- D060 check list for approval requirements
- Matrix style summary for monitoring planning



Source Description and Location

AERSCREEN

Add Site Specific Meteorology

Add Site Specific Terrain

AERMOD

Added sophistication
- terrain processing
- puff tracking
- detailed blowdown
- hour-by-hour and daily

CALPUFF

AERSCREEN Modelling

- AERSCREEN replaces SCREEN3 for AERflare modelling
- Requires meteorology and surface characterization
- AERSCREEN is a specific mode of operation of AERMOD
  - All winds blow in direction of every receptor
  - Meteorology is a μ-meteorological matrix with variation in:
    - Heating; Temperature; u*, w*; Monin-Ubukhov length
    - User selection of Bowen Ratio, surface roughness, temperature range, Albedo
  - AERflare performs lookup of meteorology conditions related to maximums

Important Pages

1. iSTART : setup
2. iNOTES : keep track
3. iFACILITY : where is the flare?
4. iFLARING : what is flaring?
5. iTERRAIN : modelling domain
6. oSUMMARY : results of assessment

ABOUT

Alberta Energy Regulator

AERflare Ver 2.01
January 10, 2014

AERflare

FLARE AIR DISPERSION MODELLING SPREADSHEET

developed for

Alberta Energy Regulator

developed by

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in association with

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Versions SS2.01.140110;M2.01.140110

LEGEND

cells	Prompt description or comment
cells	Entry prompt
cells	Required Entry for Dispersion Calculations
cells	Protected or locked calculation
cells	Warning regarding a prompt or calculation that requires special attention
cells	Default value, Locked

PAGES	INFORMATION: User information and technical reference
iPAGES	INPUTS: User will provide Inputs on these pages
oPAGES	OUTPUTS: Summary/Graphic/Reference
oPAGES	TECHNICAL OUTPUT: Calculations/Results

iSTART - AERflare Geek Backdoors

Advanced Technical Switches

Description	Variable	Units	Inputs	Default	Comment
Re-create run.bat file each time (1-Yes, 0-No)	mrunbat	--	1	1	
Add pause to run.bat file (1-Yes, 0-No)	mpause	--	0	0	
Run POSTBAT after each batch line (1-Yes, 0-No)	mpostbat	--	0	0	
Keep input files (1-Yes, 0-No)	mkeep	--	0	0	
Keep output files (1-Yes, 0-No)	mkeepout	--	0	0	
AERMOD input files- uses 0,0 origin (1-Yes, 0-No)	mrelloc	--	0	0	
AERMOD input files-export receptors (1-Yes, 0-No)	mexprec	--	1	1	
Apply BETA adjustment of u* in AERMET (1-Yes, 0-No)	mmetustar	--	1	1	BETA MMETUSTAR=1 must be used for both iUSERMET and oMODELLING. It has no effect on screening
Use BETA adjustment of low winds method 1 (1-Yes, 0-No) (horizonal meander OFF; SVmin=0.5 m/s)	mlowwind1	--	0	0	
Use BETA adjustment of low winds method 2 (1-Yes, 0-No) (horizonal meander ON; SVmin=0.3 m/s; FRAN=max 0.95)	mlowwind2	--	0	0	
Force SCREEN AERMOD Control Setting (1-Yes, 0-No)	mscreen	--	0	0	
Force Site Elevation to DEM elevation (1-Yes, 0-No)	melev	--	1	1	
DEM always download files (1-Yes, 0-No)	mdemget	--	0	0	
LCC always download files (1-Yes, 0-No)	mlccget	--	0	0	
Minimum Orifice Diameter is at Exit to Ambient (1-Yes, 0-No)	mminidialoc	--	0	0	
Synchronize settings between spreadsheets (1-Yes, 0-No)	msync	--	1	1	

Non-Default Settings

Description	Variable	Units	Inputs	Default	Comment
Ambient Temperature	ta	°C	5	5	
Average Ambient Wind Speed	ua	m/s	3.5	3.5	
PG Stability Class	ipg	--	4	4	
Wind Anemometer Reference Height	zref	m	10	10	
Qmin fraction of Qmax	qmin/qmax	--	0.125	0.125	
SO_2 1h Air Quality Objective	obj_so2	µg/m³	450	450	
H_2S 1h Air Quality Objective	obj_h2s	µg/m³	14	14	
Receptor Resolution for Maximum Concentration	dxmin	m	20	20	
Raw, Fuel and Lift Gas Temperature before Combustion	tginit	°C	5	5	
Minimum value of Sigma-V (0.01 to 1.0 m/s)	svmin	m/s	0.2	0.2	
Minimum wind speed (0.01 to 1.0 m/s)	wsmin	m/s	0.2828	0.2828	
Maximum meander parameter (0.5 to 1.0) (optional for MLOWWIND2)	franmax	--	0.95	0.95	
Receptor hill height grid resolution	hhdx	m	200	200	
Modelling domain for receptor grid	rmaxdist	m	10000	10000	
Modelling domain buffer beyond receptor grid	dombuf	m	5000	5000	
Minimum number of data point in a period to apply RBC	mndata	--	7884	7884	
Number of virtual sources for HbH modelling	nsources	--	9	9	
Flag pole receptor height	zflag	m	0	0	
Radius for AERscreen roughness	rrough	m	3000	3000	
Radius for AERscreen albedo and bowen ratio	ralbbow	m	5000	5000	
Run Flags (see switch table to right)	myrun	--	0	0	
User Period Selection (Annual or Month)	mflmon	--	1	1	
Blowdown Distribution of Mass Option	mdist	--	0	2	
Blowdown User Entry of Qmax	qmax	--	blank	blank	
Blowdown User Entry of Qtotal	qtotal	--	blank	blank	
Flare Tip High Speed Exit Velocity Check	flagsonicue	--	0	0	
Land Use around the site	well_lu	--	1	1	

- Several backdoor options are made available for recreational use
- Flags for non-default settings

MyRun Model Cases

1	2	3	4	5	6
☐	☐	☐	☐	☐	☐

oSUMMARY - D060 References

oSummary Page

- Table of D060 dependencies and limits
- D060 Figure 4 – Approval required check
- Updated the modelling output section
- Explicit D060 conditions on flaring or modelling with pass/see requirements

AER D060 Permit Conditions	D060 Ref.	Test	This Application	Allowed	Requirements
Volume Allowance Threshold Tier for Gas Wells	3.3.1[2]		3		Based upon the Lahee classication See D060-3.3.1[2a] for tier limits
H_2S gas concentration (%)	3.3.1[1]	See Requirements	30.1	5	Permit is required
Volume per Zone (10^3m^3)	3.3.1[2a]	See Requirements	400.00	200	Volume allowance is based upon well before re-classification
Total Volume (10^3m^3)	3.3.1[2d]	PASS	22.5	200	Volume allowance is based upon well before re-classification
Event Sulphur Emissions (t)	7.12.1	See Requirements	163.280	1	Modelling is required
Event Duration (min)	7.12.5[1]	See Requirements	4608	15	Modelling is required
H_2S more than 1% (or 10 mol/kmol)	7.12.1	See Requirements	30.1	1	Modelling is required
Small Volume: low sulphur rate (t/d)	3.3.2[2a]	See Requirements	102.050	1	Modelling is required
Small Volume: low gas volume over duration (10^3m^3)	3.3.2[2b]	PASS	22.5	50	NO permit is required
Conditions to Apply for a Blanket Permit: total volume per site (10^3m^3)	3.5.3[5a]	PASS	22.5	100	Blanket Permit could be considered
Conditions to Apply for a Blanket Permit: sulphur emissions per site (t)	3.5.3[5b]	See Requirements	163.3	10	Blanket Permit is NOT allowed
Conditions to Apply for a Blanket Permit: risk-based criteria met	3.5.3[5c]	NA	NA	NA	Requires refined modelling
Conditions to Apply for a Blanket Permit: complex terrain issues	3.5.3[5d]	See Requirements	COMPLEX	PARALLEL	Blanket Permit would be considered only with modelling backup
Temporary Flaring Permit Process: D060 Flowchart (Figure 4)	**D060 Ref.**	**Test**	**This Application**	**Allowed**	**Requirements**
Is Well Classified as Critical ?	3.3.1[1]	○ Critical ◉ Non-Critical			
H2S > 5%	3.3.1[1]	◉ Yes ○ No	30.10%	5%	Permit is required
H2S > 1 %	3.3.2[1a]	◉ Yes ○ No	30.10%	1%	Air quality evaluation is required (7.12)
Flared Volume > Volume Allowance (10^3m^3)	3.3.1[2]	◉ Yes ○ No	22.5	200	Volume exceedance permit is required
Small Volume Exemption limits exceeded?	3.3.1[2a,2b,2c]	◉ Yes ○ No			
Is Temporary Flaring Permit Required?	3.3.1	◉ Yes ○ No	Permit is required and permit to exceed the volume allowance threshold is required		

iNOTES - ** IMPORTANT **

1. Describe the flaring event
2. Frequency of flaring
3. Flaring reduction
4. Assumptions
5. Space for other notes about what you did to complete the flaring assessment...

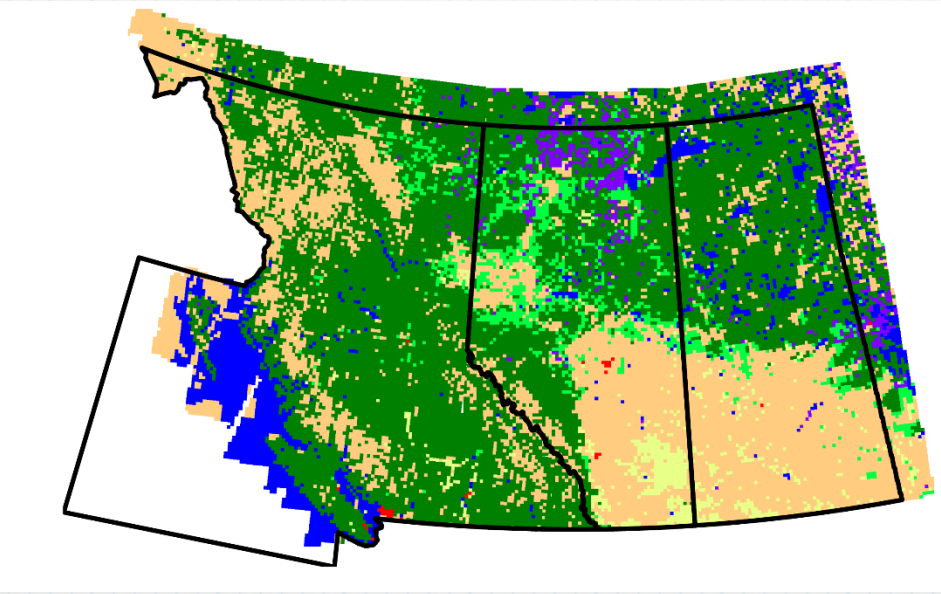
iFACILITY

Mapping Projection		UTM (NAD83)	
UTM Zone		11	11 (120W - 114W - Northern Hemisphere)
Surface Coordinates of Flare	X Coord (m Easting) or Longitude	481234	
	Y Coord (m Northing) or Latitude	6112345	
Flare Base Elevation	m	655.8701328	
Land-use Characterization		Default	Land-use classification based upon Surface Coordinates:Grassland
Operations to be Conducted (cleanup/workover/testing/etc)			MUST ENTER DESCRIPTION
Total Volume of Raw Gas to be Flared during Clean-up and Testing of ALL Zones	10^3m^3 (15°C and 101.325 kPa)	22.5	Single Zone so Total (iFacility Page) must match Subject Zone (iFlaring Page)
Total Estimated Days with Flaring for ALL Zones	days	8	Reduce Subject Zone Volume or Increase Average Rate to Reduce Duration to 72 hours
Is Well tied into Production Facilities?		(•) Yes ( ) No	Provide Details on Attachments Page
Information on the Feasibility of In-Line Well Testing Attached?		(•) Yes ( ) No	Provide Details on Attachments Page
Previous Flaring / Incineration Permits(s) for this location in last 12 months?		( ) Yes (•) No	
	Permit Number(s)		
	Date(s)		
Requested Permit Start Date	mm/dd/yyyy (best-case)	November 1, 2012	
Requested Permit End Date	mm/dd/yyyy (worst-case)	December 30, 2012	

- LOCATION, LOCATION, LOCATION !!!
- Land-use
- Describe what/why you are flaring ... add more information on iNOTES ... ** IMPORTANT **
- Date range you plan on flaring for ...
  - Model for specific date
  - Or entire year

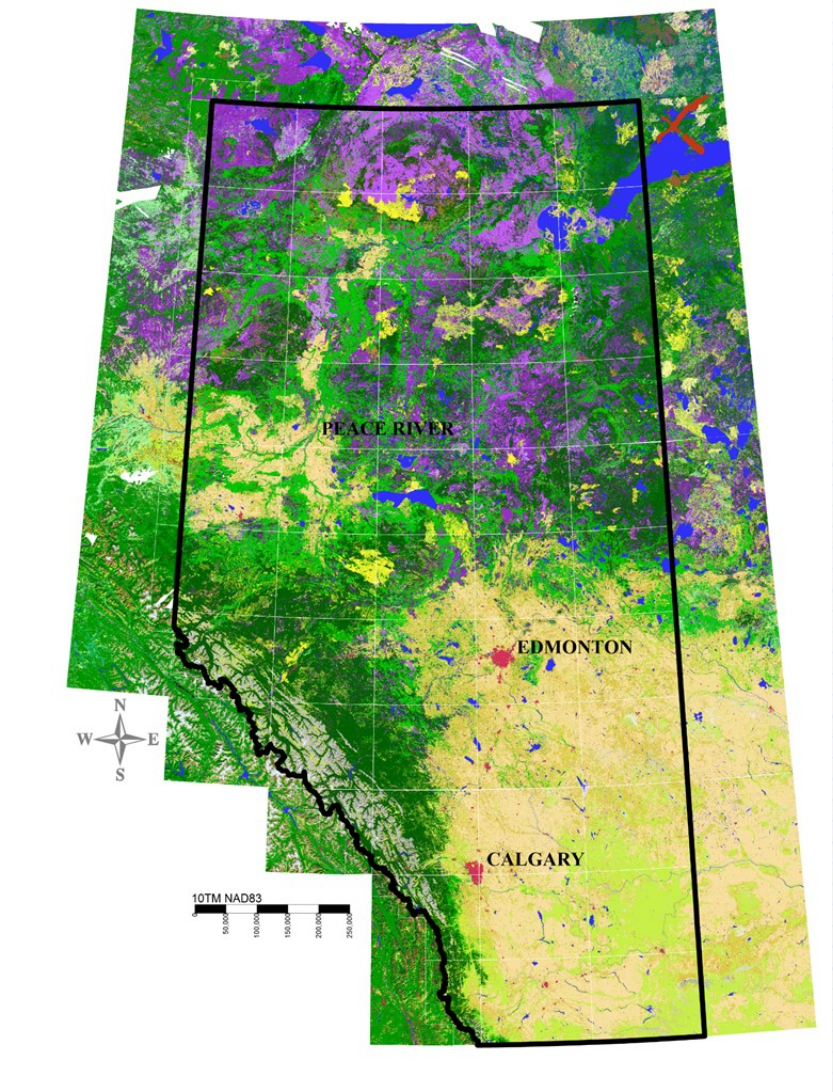
How AERSCREEN is implemented

- AERflare uses 8-default meteorology files
  - Deciduous; Coniferous; Swamp; Grassland; Grassland; Water; Urban; Desert
  - Landcover is prescribed by flare location and lookup



		Description	Alberta Fraction
	10	Coniferous Forest	34.8%
	20	Deciduous Forest	14.7%
	30	Cultivated Land	29.4%
	40	Grassland	9.1%
	50	Urban	0.5%
	60	Swamp	7.9%
	70	Water	3.7%
	80	Desert Shrubland	0.0%

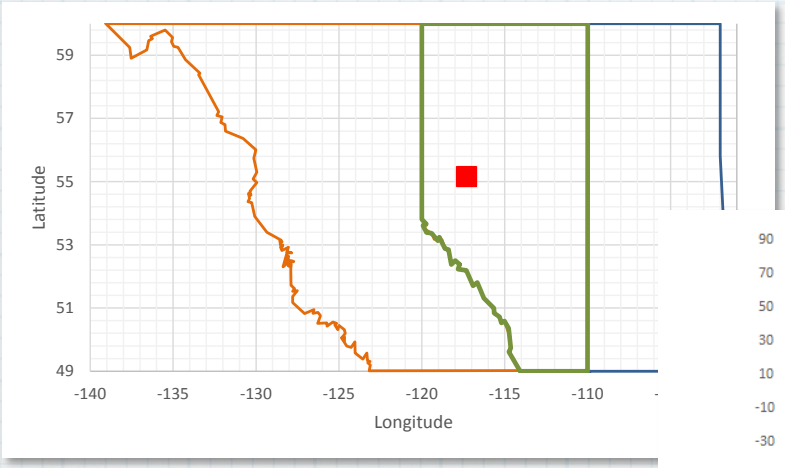
Refined - Site Specific Meteorology

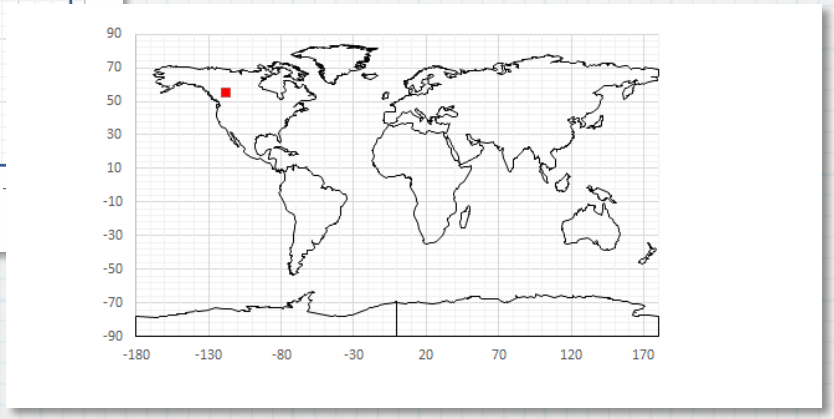


- Land use created from full detailed Canadian land use shape files
- Uses MM5 data extraction for AERMET and CALMET
- Processing following AERSURFACE for AERflare
- Processing using CALMET for ABflare

iLOCATION

- Check if you entered the correct coordinates
- Coordinates will determine the land-use and land-use strongly impacts the air dispersion modelling





iFLARING

Flaring Details	UNITS	ENTRY	WARNINGS
Subject Zone or Source of sour gas		Leduc	
Scenario Name	(operation such as cleanup or variable such as fuel gas)	Example 1-Same as ERCBflarev1.05 Released	
Time of Year to Model the Flare	--	Annual	
Flare Stack Tip Exit Height	m	3[illegible]	
Flare Stack Tip Exit Diameter	mm	305	
Requested Maximum Raw Gas H_2S Concentration for **Subject** Zone or Source	% (for Permits round up to 0.5% increment)	[illegible].10%	PERMITS ARE FOR INCREMENTS OF 0.5%

- Scenario Name
  - Documentation
  - iterations
- Time of Year
  - Annual
  - Month
- Height and diameter
  - Actual not pseudo
- H2S concentration
  - Maximum, or
  - Licensed

iFLARING

Planned Non-Routine Flaring

	Flaring Type?	◉ Continuous or Steady ○ Transient	
Continuous or Steady	UNITS	ENTRY	WARNINGS
Maximum Raw Gas Flow Rate for Source of Sour Gas	$10^3m^3/d$ (15°C and 101.325 kPa)	250	
MUST enter any 2 of the fields: i) **VOLUME** of Raw Gas to be Flared ii) **AVERAGE FLOW RATE** of Raw Gas iii) **DURATION** of Flaring	i) **Volume** 10^3m^3 (15°C and 101.325 kPa)	400	--
	ii) **Average Flow Rate** $10^3m^3/d$ (15°C and 101.325 kPa)	125	--
	iii) **Duration** hours		76.8

- Assessment Type
  - From iSTART
- Flaring type
  - Continuous or Steady
  - Transient Blowdown
- Three flaring rates are analyzed
  - Max rate
  - Mid rate
  - Low rate

    Low Rate = Max Rate/8

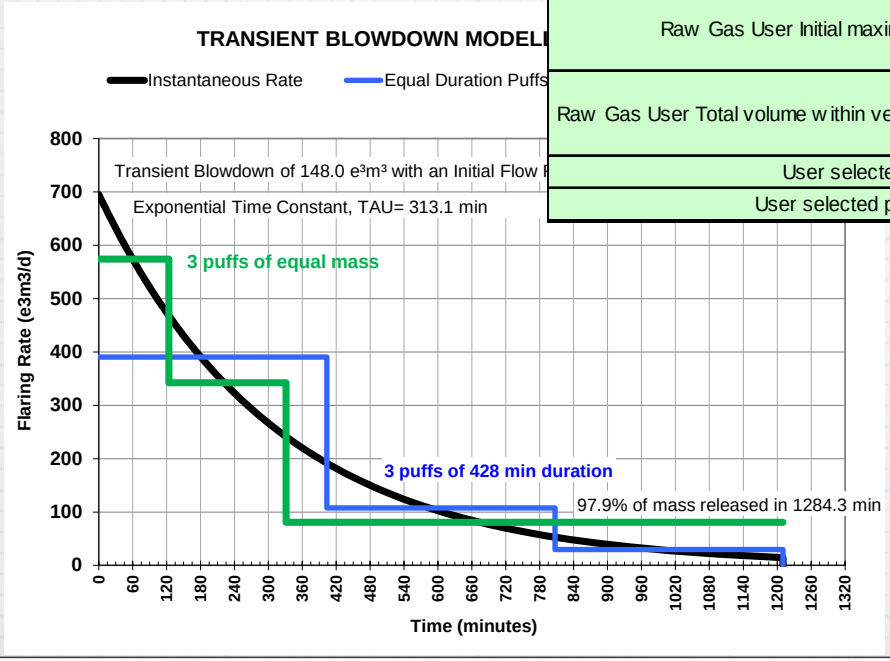
iFLARING

- Transient source initial conditions
- Fuel gas
- Lift gas
- Flaring assist
  - Air Assist
  - Steam assist
- Gas composition

oBlowdown

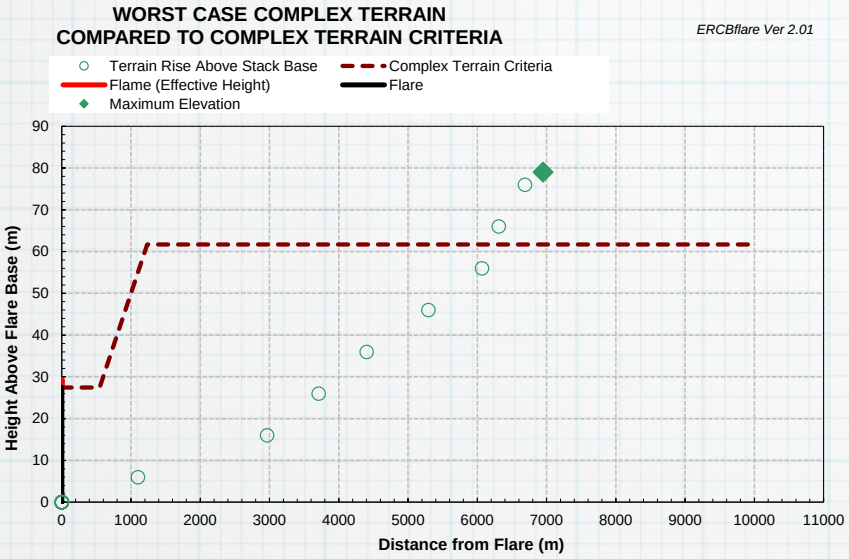
AERflare default blowdown is three steps

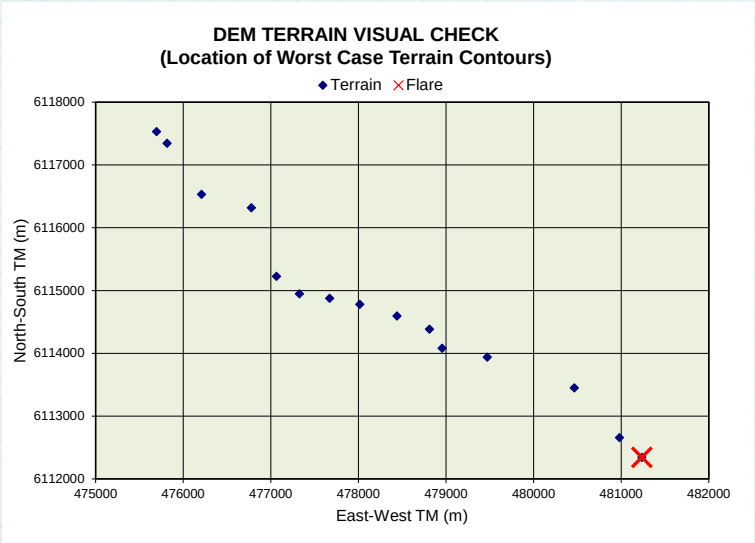
Transient Source	UNITS	ENTRY
Expected Maximum Initial Pressure, PRESS0	kPa (gauge)	4200
Expected Minimum Initial Gas Temperature, TEMP0	°C	30
Expected Minimum Final Pressure, PRESS1	kPa (gauge)	0
Pipeline/Vessel Inside Diameter, VESSELDIA	m	0.4364
Pipeline/Vessel Length, VESSELLEN	m	25100
Minimum Orifice Diameter, ORIFICE_DIA	mm	43
Discharge Coefficient, DCOEFF	--	0.6
Select the way the blow down curve is converted from a continuous curve to discrete steps MDIST	--	○ 1. Equal Duration ◉ 2. Equal Mass
Raw Gas User Initial maximum flow rate, QMAX	$10^3 m^3/d$ (15°C and 101.325 kPa)	
Raw Gas User Total volume within vessels/pipes, QTOTAL	$10^3 m^3$ (15°C and 101.325 kPa)	
User selected # of puffs, NPUFFS	--	3
User selected puff duration, PUFDUR	min	



The number of steps in blowdown is not limited in ABflare

iTERRAIN



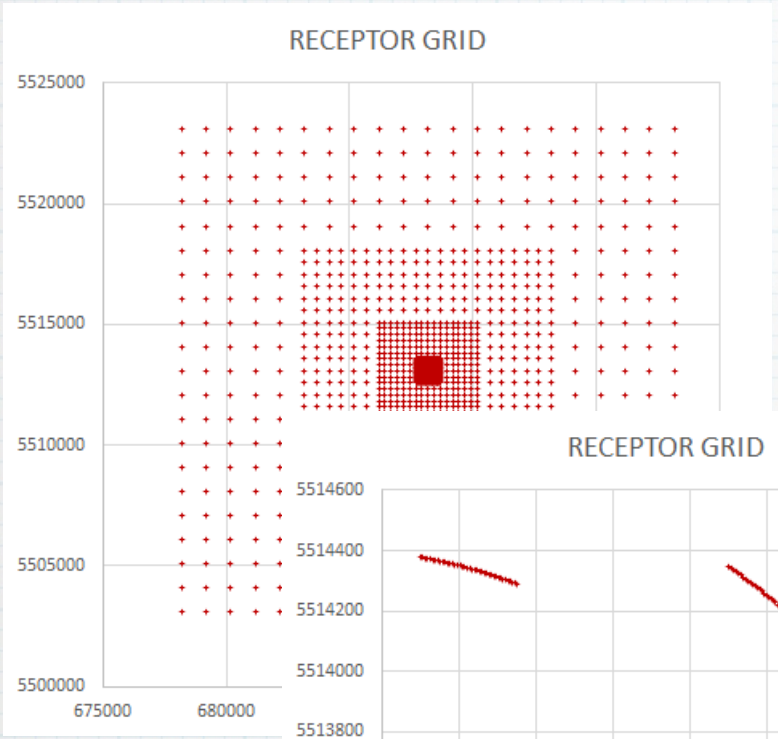


Worst case terrain compared to complex terrain criteria (AERflare)

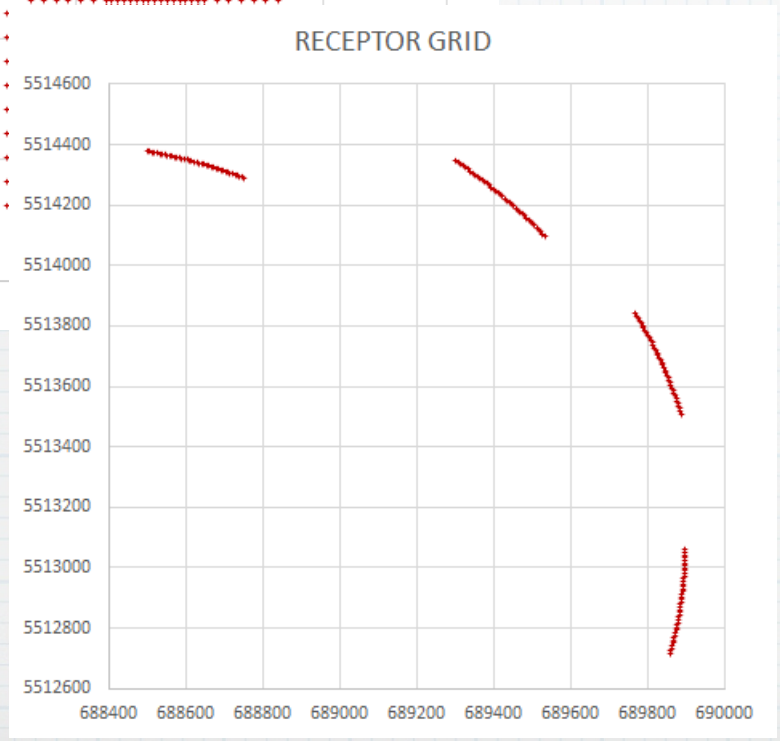
AERflare calculates both parallel and worst case terrain, the complex terrain criteria is no longer used

Worst case terrain points relative to stack location (AERflare)

AERflare and ABflare Site Specific iUSERTER

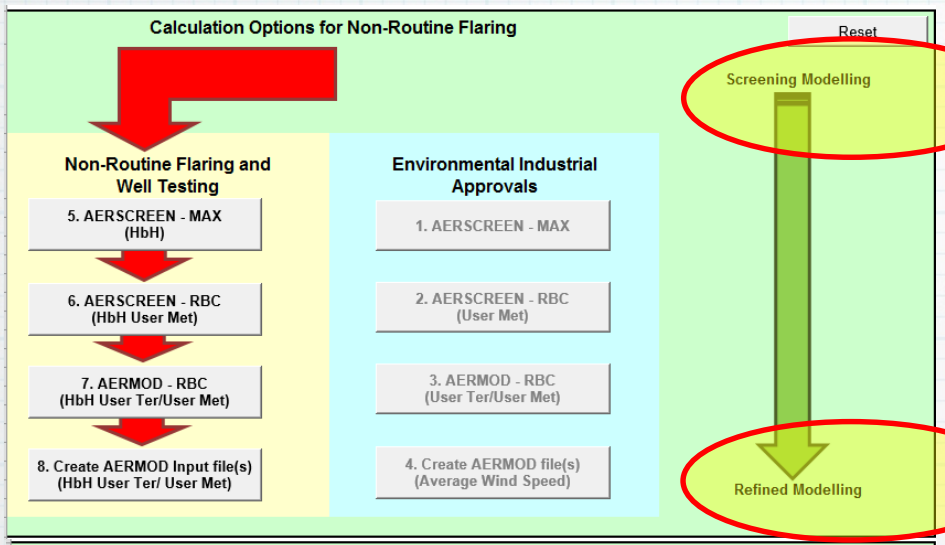


Generic receptor grid creation

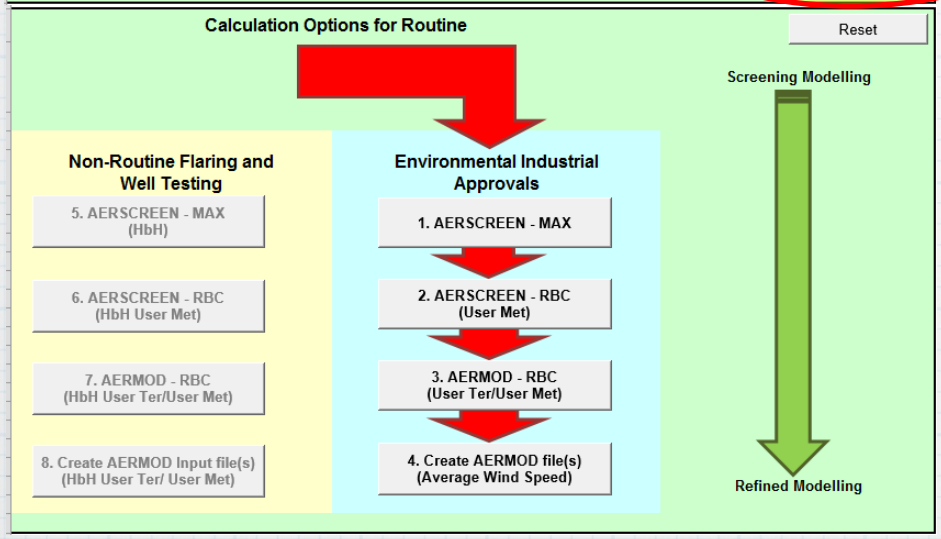


Example user receptor grid input

oMODELLING



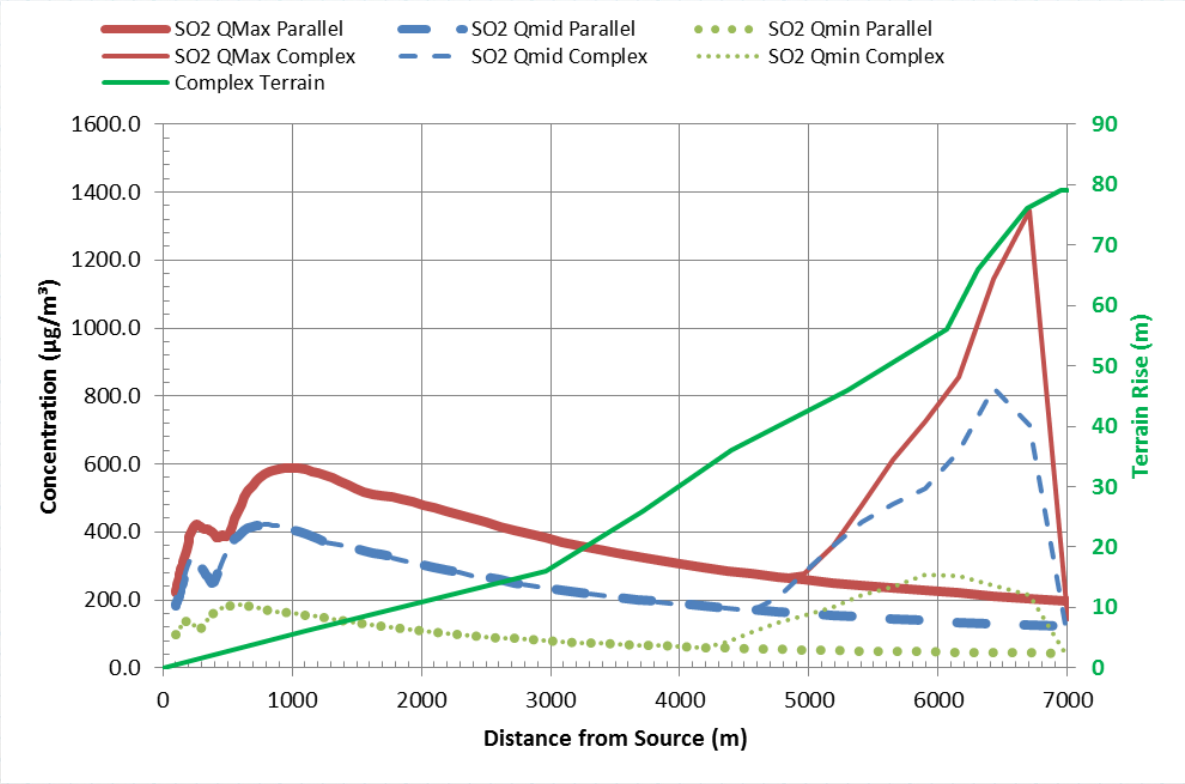
Non-Routine Flaring and Well Tests



Flaring Evaluation Assessment

oFIGURE1

- oFigure1 shows results for
  - 3-rates (Qmax, Qmid, Qmin)
  - Parallel terrain & elevated terrain predictions
  - Terrain elevations

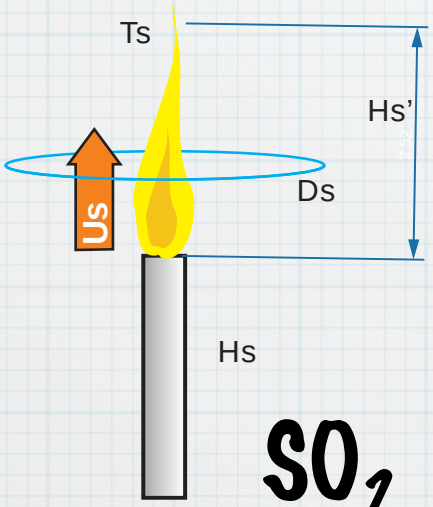


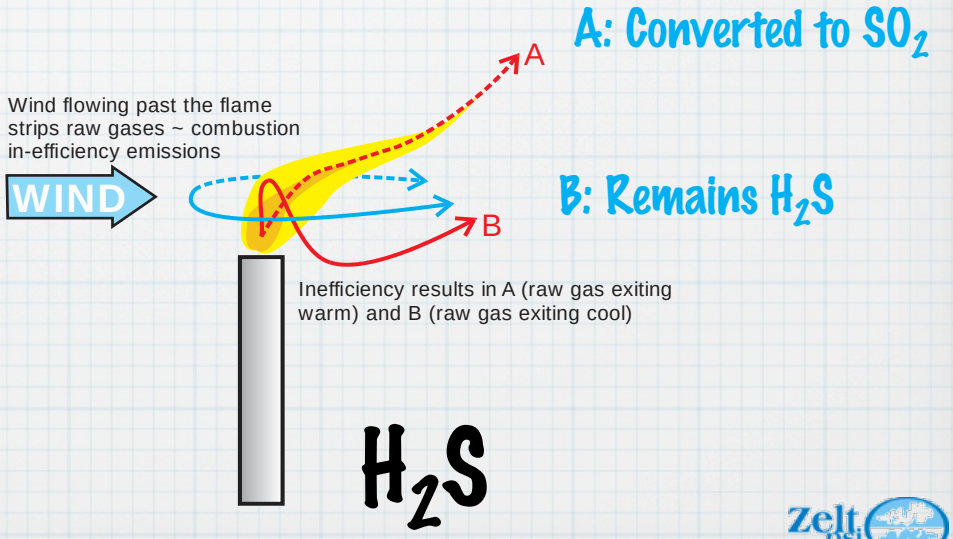
SO_2 and H_2S

- AERflare and ABflare use a flare conversion efficiency model
- Conversion efficiency is a function of:
  - Heating value
  - Meteorology
- Source parameters are function of efficiency and change hourly with meteorology
- SO_2 emissions are worse case 100% conversion
  - No credit for in-efficiency
- H_2S emissions based upon inefficiency
  - Assumes a fraction of flared gas is stripped away, ∴ H_2S stays as H_2S

SO_2 and H_2S

- SO_2 source parameters based upon heat and momentum energy balance
- H_2S source parameters based upon momentum of stripped gas and assumed temperature

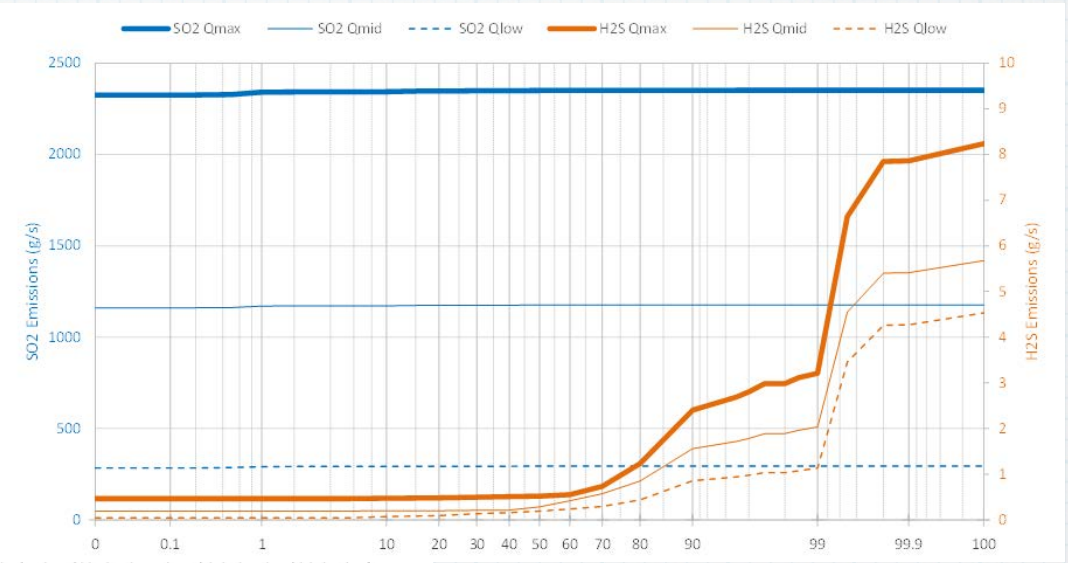




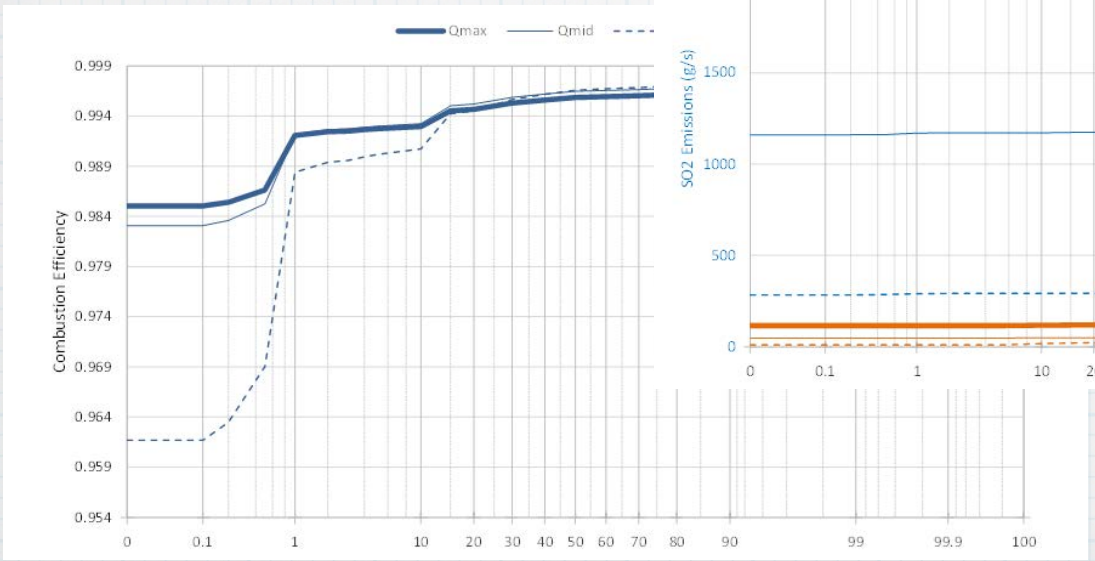
oFIGURE2

- Page for Non-Routine hour-by-hour source
- Emissions Probability for SO_2 and H_2S
- Conversion Efficiency Probability

Mass Emission Rates



Efficiency



Questions...