

OWNER

Air Emissions Inventory and Applicability

Calculation



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TORUS

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1. OBJECTIVE

This calculation estimates the potential to emit (PTE) of the for criteria pollutants, volatile organic compounds (VOC), hazardous air pollutants (HAP) and greenhouse gases (GHG). It compares the results with the federal and thresholds that decide which air rules apply, and it determines whether liquids tank T-101 is a storage vessel affected facility under 40 CFR 60 Subpart OOOOb.

2. METHODOLOGY

TORUS identified every emission source on the station: the H-101 line heater, the G-101 standby generator, fugitive leaks from piping components, maintenance blowdowns and pig receiver venting, the continuous analyzer and sample-system vents, and T-101 with its truck loadout. Each source was estimated with the EPA method appropriate to it, and the results were summed by pollutant.

The line heater uses AP-42 Section 1.4 factors for small uncontrolled boilers. These factors are based on heat input, so emissions follow directly from the firebox rating and are independent of the fuel heating value. Sulfur dioxide was also calculated by mass balance at the tariff maximum sulfur content, and the larger value was carried. Carbon dioxide was calculated both with the 40 CFR 98 Subpart C default factor and by carbon balance on the design gas composition; the carbon balance gives the larger value and governs.

The generator uses AP-42 Section 3.2 factors for four-stroke rich-burn engines. Its PTE is based on 500 hours per year, the EPA default for emergency generators, and the 40 CFR 60 Subpart JJJJ emission standards are shown as the regulatory ceiling.

Fugitive leaks use the average emission factors of the EPA 1995 Protocol for oil and gas production operations, applied to a component count for the station. Gas-service leaks are speciated by the design gas composition.

Blowdown and pig receiver emissions use the section volumes and initial states of PRO-CAL-008, with gas densities from the GERG-2008 equation of state. Each event is taken to vent to atmospheric pressure, which is conservative because the blowdowns end at about 5 psig.

T-101 receives liquid dumped directly from the V-101 filter separator at line pressure, so flashing dominates its emissions. The flash factor and flash gas molecular weight are those of PRO-CAL-007, from a Peng-Robinson flash of condensate saturated with the design gas at 1,150 psig and 45 °F down to 14.1 psia and 60 °F. The VOC, methane and n-hexane fractions of the flash gas were taken from the same flash. The black-oil correlations of Vasquez-Beggs (848 scf/bbl) and Standing (607 scf/bbl) give lower flash factors, because they are fitted to crude oils; the equation-of-state result is used.

Standing and working losses follow AP-42 Section 7.1, and truck loadout losses follow AP-42 Section 5.2. The 0000b comparison includes flash, standing and working losses, but not loadout, which is a separate source.

Gas properties come from the GERG-2008 equation of state (CoolProp 8.0) for the design composition in GEN-DB-001.

3. DESIGN INPUTS

The inputs are listed in Table 3-1. Values carried from other project documents name that document.

Table 3-1: Design Inputs

Input	Value	Source
Gas composition	Design case; MW 18.46; higher heating value 1,103.7 Btu/scf	GEN-DB-001
Gas weight fractions	Methane 0.769; VOC (propane and heavier) 0.094; CO2 0.021; n-hexane 0.0047	Design composition
Tariff maximum total sulfur	5 grain/100 scf	GEN-DB-001 (HOLD H-13)
H-101 firebox rating and operation	6.0 MMBtu/h, 8,760 h/yr	MEC-LST-002; PRO-CAL-004
G-101 rating and fuel input	60 kWe (87.5 bhp); 12,500 Btu/kWh, 0.75 MMBtu/h	PRO-CAL-010 (HOLD H-15)
G-101 hours	100 h/yr maintenance and readiness; 500 h/yr for PTE	40 CFR 60.4243(d); EPA guidance
Blowdown sections and initial states	See Table 6-3	PRO-CAL-008
Continuous analyzer and bypass vents	3.6 standard L/min, 183 scf/d	MEA-CAL-004
T-101 throughput	350 bbl/yr, recommended enforceable 12-month rolling limit	This calculation, Section 7 (liquids rate HOLD H-20)
Flash factor and flash gas	1,000 scf per stock-tank bbl; MW 25.6; VOC 38.5 %, methane 43.4 %, n-hexane 0.36 % by weight	PRO-CAL-007 (HOLD H-12)
V-101 liquids, design allowance	2 bbl/d free liquid plus 52 pig slugs of 5 bbl, about 990 bbl/yr	PRO-CAL-005 (HOLD H-20, H-16)
T-101 liquid	Condensate, 60 °API, weathered stock taken as RVP 10	Assumed pending liquid analysis
T-101 geometry	9 ft 6 in OD x 8 ft shell, cone roof, white	MEC-DS-004
Meteorology	City: mean daily maximum 71.5 °F, minimum 49.9 °F, insolation 1,500 Btu/ft ² -d	AP-42 Table 7.1-7 (TBV)

4. ASSUMPTIONS

1. T-101 receives no more than 350 bbl of liquid in any 12-month period. The Owner will take this as a legally and practicably enforceable limit. *Verification required (HOLD H-20).*
2. The flash factor of 1,000 scf per stock-tank bbl is the C8 heavy-end result rounded up; the flash gas properties are those of the C7 case, the richest in VOC. *Verification required by pressurized liquid analysis (GPA 2103 or GPA 2186) (HOLD H-12).*
3. Component counts (879 in gas service, 52 in light-liquid service) are estimated from the equipment and instrument register. *Verification required: recount from the construction-issue P&IDs.*
4. Each blowdown section vents from its PRO-CAL-008 initial state to atmospheric pressure. Frequencies are three per year for sections S1 and S2, two per year for section S3 alone after a trip, one per year for S3 with the outlet lateral, and 52 pig receipts per year. *Pigging frequency HOLD H-16.*
5. The heater fires at its full rating for 8,760 h/yr. In practice it runs only in winter, so actual emissions will be lower.
6. The generator emission factors are replaced by the certified engine family data when the engine is purchased. *Verification required (HOLD H-15).*
7. Global warming potentials are those of 40 CFR 98 Table A-1 in force from reporting year 2025: methane 28, nitrous oxide 265.

5. REFERENCES

1. US EPA, AP-42 Compilation of Air Emission Factors, 5th Edition: Section 1.4 Natural Gas Combustion (1998); Section 3.2 Natural Gas-fired Reciprocating Engines (2000); Section 5.2 Transportation and Marketing of Petroleum Liquids (2008); Section 7.1 Organic Liquid Storage Tanks (2020).
2. US EPA, EPA-453/R-95-017, Protocol for Equipment Leak Emission Estimates (1995), Table 2-4.
3. Vasquez, M. and Beggs, H. D., Correlations for Fluid Physical Property Prediction, Journal of Petroleum Technology, June 1980 (comparison only).
4. 40 CFR 60 Subpart OOOOb, Standards of Performance for Crude Oil and Natural Gas Facilities (2024).
5. 40 CFR 60 Subpart JJJJ, Standards of Performance for Stationary Spark Ignition Internal Combustion Engines, Table 1.
6. 40 CFR 98 Subparts A, C and W, Mandatory Greenhouse Gas Reporting.
7. 252:100-7, Department of Environmental Quality, Permits for Minor Facilities (thresholds TBV against the rule in force).

8. US EPA memorandum, Calculating Potential to Emit for Emergency Generators, September 6, 1995.
9. GEN-DB-001, Basis of Design; MEC-LST-002, Mechanical Equipment List; MEC-DS-004, T-101 Liquids Tank.
10. PRO-CAL-004, Line Heater H-101; PRO-CAL-005, Filter Separator V-101; PRO-CAL-007, Pressure Relief Devices and Tank Venting; PRO-CAL-008, Blowdown, Vent Header and Vent Stack; PRO-CAL-010, Fuel Gas System.
11. MEA-CAL-004, Sampling System Design.

6. CALCULATION

6.1. H-101 LINE HEATER

AP-42 factors are given per million scf of gas at 1,020 Btu/scf, so the hourly emission rate of each pollutant follows from the heat input Q :

AP-42 Section 1.4, Tables 1.4-1 and 1.4-2

$$E_{NO_x} = \frac{EF}{1020} Q = \frac{100}{1020} \times 6.0 = 0.588 \text{ lb/h}$$

At 8,760 h/yr this is 2.58 tpy of nitrogen oxides. Carbon monoxide at 84 lb/MMscf is 2.16 tpy.

The heater burns $6.0 \times 10^6 / 1,103.7 = 5,436$ scf/h. At the tariff maximum sulfur content the sulfur dioxide rate is:

$$E_{SO_2} = 5,436 \times \frac{0.05}{7,000} \times \frac{64.07}{32.07} = 0.078 \text{ lb/h}$$

or 0.34 tpy, which exceeds the AP-42 value of 0.015 tpy and is carried.

The design gas contains 1.133 mol of carbon per mol of gas. Burned completely, 47.6 MMscf/yr produces:

$$m_{CO_2} = \frac{47.6 \times 10^6}{379.5} \times 1.133 \times 44.01 = 2,838 \text{ t/yr}$$

The 40 CFR 98 Subpart C default of 53.06 kg/MMBtu gives 2,789 t/yr. The carbon balance is 1.8 % higher and is used.

6.2. G-101 STANDBY GENERATOR

The 60 kWe generator burns 0.75 MMBtu/h at full load. With the AP-42 four-stroke rich-burn factor of 2.21 lb/MMBtu, nitrogen oxides are 1.66 lb/h, or 0.41 tpy at 500 h/yr. Table 6-1 compares the AP-42 estimate with the JJJJ emission standards. The JJJJ carbon monoxide standard for this size class is a

certification ceiling far above real engine performance, so PTE is based on AP-42 until the certified engine data are received. Even at the JJJJ ceiling, facility carbon monoxide would be 21 tpy, below the 40 tpy level that matters for authorization.

Table 6-1: G-101 Emissions, AP-42 and JJJJ Ceiling

Pollutant	AP-42, lb/MMBtu	AP-42, lb/h	PTE at 500 h, tpy	JJJJ standard, g/hp-h	JJJJ at 500 h, tpy
NO _x (JJJJ: NO _x + HC)	2.21	1.66	0.41	10	0.48
CO	3.72	2.79	0.70	387	18.7
VOC	0.030	0.022	0.006		
PM (total)	0.019	0.015	0.004		

6.3. FUGITIVE COMPONENTS

Table 6-2 applies the 1995 Protocol factors to the component count. Total organic compound (TOC) leakage is 0.968 kg/h in gas service and 0.049 kg/h in light-liquid service, or 9.35 tpy and 0.48 tpy. Gas-service leaks contain 9.4 % VOC by weight, so fugitive VOC is $9.35 \times 0.094 + 0.48 = 1.36$ tpy. Methane is 7.19 tpy.

Table 6-2: Fugitive Components and Emission Factors

Component	Gas service, count	Gas factor, kg/h	Gas TOC, kg/h	Light liquid, count	Liquid factor, kg/h	Liquid TOC, kg/h
Valves	145	0.0045	0.653	10	0.0025	0.025
Connectors	480	0.00020	0.096	24	0.00021	0.005
Flanges	230	0.00039	0.090	14	0.00011	0.002
Open-ended lines	12	0.0020	0.024	2	0.0014	0.003
Relief valves	4	0.0088	0.035	1	0.0075	0.008
Other (closures, meters)	8	0.0088	0.070	1	0.0075	0.008
Total	879		0.968	52		0.049

6.4. BLOWDOWNS, PIG RECEIVER AND ANALYZER VENTS

The mass vented from each section is its volume times the difference between the gas density at the initial state and at atmospheric pressure:

$$m = V[\rho(P_0, T_0) - \rho(0 \text{ psig}, T_0)]$$

For section S1 at 1,150 psig and 45 °F, $\rho = 5.104 \text{ lb/ft}^3$ (compressibility $Z = 0.778$), and $m = 392.8 \times (5.104 - 0.047) = 1,986 \text{ lb}$ per event. Table 6-3 gives every section. Blowdowns and pigging vent 19,040 lb/yr (389 Mscf/yr), which contains 0.90 tpy of VOC and 7.32 tpy of methane. Venting one section at a time, as the vent stack design requires, does not change the annual total.

Table 6-3: Blowdown and Pig Receiver Venting

Section	Volume, ft^3	Initial state	Vented per event, lb	Events per year	Vented per year, lb
S1 inlet, BDV-181	392.8	1,150 psig, 45 °F	1,986	3	5,958
S2 meter and heater, BDV-182	370.3	1,145 psig, 45 °F	1,862	3	5,586
S3 outlet after a trip, BDV-183	22.6	1,150 psig, 44 °F	115	2	230
S3 with outlet lateral, BDV-183	169.4	1,200 psig, 45 °F	903	1	903
PR-101 barrel, BDV-102	24.2	1,150 psig, 45 °F	122	52	6,363
Total					19,040

The analyzer and sample-system vents discharge 183 scf/d of process gas continuously, or 66.8 Mscf/yr (3,266 lb/yr). This contains 0.15 tpy of VOC and 1.26 tpy of methane.

6.5. T-101 LIQUIDS TANK

Each stock-tank barrel reaching T-101 releases 1,000 scf of flash gas with a molecular weight of 25.6, of which 38.5 % by weight is VOC. The flash VOC per barrel is therefore:

PRO-CAL-007, Peng-Robinson flash

$$e_{flash} = \frac{1,000}{379.5} \times 25.6 \times 0.385 = 26.0 \text{ lb VOC/bbl}$$

Standing and working losses follow AP-42 Section 7.1 for a 9 ft 6 in x 8 ft cone-roof tank. At a liquid surface temperature of 522.4 °R the true vapor pressure is 5.47 psia. The standing loss is 544 lb/yr regardless of throughput, and the working loss adds 0.36 lb per barrel. The storage vessel emission as a function of the annual throughput Q is:

$$E_{T-101} = \frac{544 + (26.0 + 0.36) Q}{2,000} \text{ tpy}$$

Setting $E_{T-101} = 6 \text{ tpy}$ gives the largest throughput that keeps T-101 below the 0000b storage vessel threshold:

$$Q_6 = \frac{6 \times 2,000 - 544}{26.33} = 435 \text{ bbl/yr}$$

Table 6-4 compares this with the liquid volumes the station can expect. Dehydrated residue gas that meets the 15 °F hydrocarbon dewpoint of the delivery specification carries no free liquid in normal operation, so the liquid reaching V-101 is mainly what the Owner's pigs push ahead of them. At one receipt a week and 1 to 5 bbl per receipt, that is 52 to 260 bbl/yr. The 2 bbl/d free-liquid allowance of PRO-CAL-005 is a vessel sizing margin, not an expected rate; if it occurred year-round the tank would emit 13 tpy.

Table 6-4: T-101 VOC Against Annual Liquid Throughput

Case	Throughput, bbl/yr	Flash VOC, tpy	Standing and working, tpy	T-101 VOC, tpy	Against 6 tpy
Pigging, 1 bbl per weekly receipt	52	0.68	0.28	0.96	Below
Pigging, 5 bbl per weekly receipt	260	3.39	0.32	3.70	Below
Recommended enforceable limit	350	4.55	0.34	4.88	Below
Throughput giving 6 tpy	435	5.65	0.35	6.00	At threshold
Design allowance of PRO-CAL-005	990	12.86	0.45	13.31	Above

Note 1: With the C7 flash factor of PRO-CAL-007 (1,170 scf per stock-tank bbl), T-101 at 350 bbl/yr would emit 5.65 tpy, still below 6 tpy; 6 tpy would be reached at 373 bbl/yr.

A limit of 350 bbl/yr is recommended. It is more than 30 % above the highest pigging estimate, so ordinary operation will not approach it, and it keeps T-101 below 6 tpy even if the heavy end of the liquid turns out to be as light as C7. A limit at the 435 bbl/yr threshold was rejected because it leaves no margin for the flash factor, which remains provisional (HOLD H-12). Truck loadout at 350 bbl/yr adds 76 lb/yr (0.04 tpy), which is not part of the storage vessel total.

7. RESULTS AND CONCLUSIONS

Table 7-1 gives the facility PTE, and Figure 7-1 compares each pollutant with the permitting thresholds. The station is a minor source for every pollutant by a wide margin. VOC is the largest, at 7.47 tpy, and Figure 7-2 shows that T-101 contributes 66 % of it at the recommended throughput limit.

Table 7-1: Facility Potential to Emit

Pollutant	H-101	G-101	Fugitives	Blowdowns and pigging	Analyzer vents	T-101 and loadout	Total, tpy
NOx	2.58	0.41					2.99
CO	2.16	0.70					2.86
VOC	0.14	0.01	1.36	0.90	0.15	4.92	7.47

Pollutant	H-101	G-101	Fugitives	Blowdowns and pigging	Analyzer vents	T-101 and loadout	Total, tpy
PM (total)	0.20	0.00					0.20
SO ₂	0.34	0.00					0.34
HAP (total)							0.22
GHG, t CO ₂ e/yr	2,841	21	183	186	32	130	3,393

Note 1: HAP is dominated by n-hexane (0.21 tpy). The largest single HAP is far below the 10 tpy major source threshold.

Figure 7-1. Facility Potential to Emit Against Permitting Thresholds

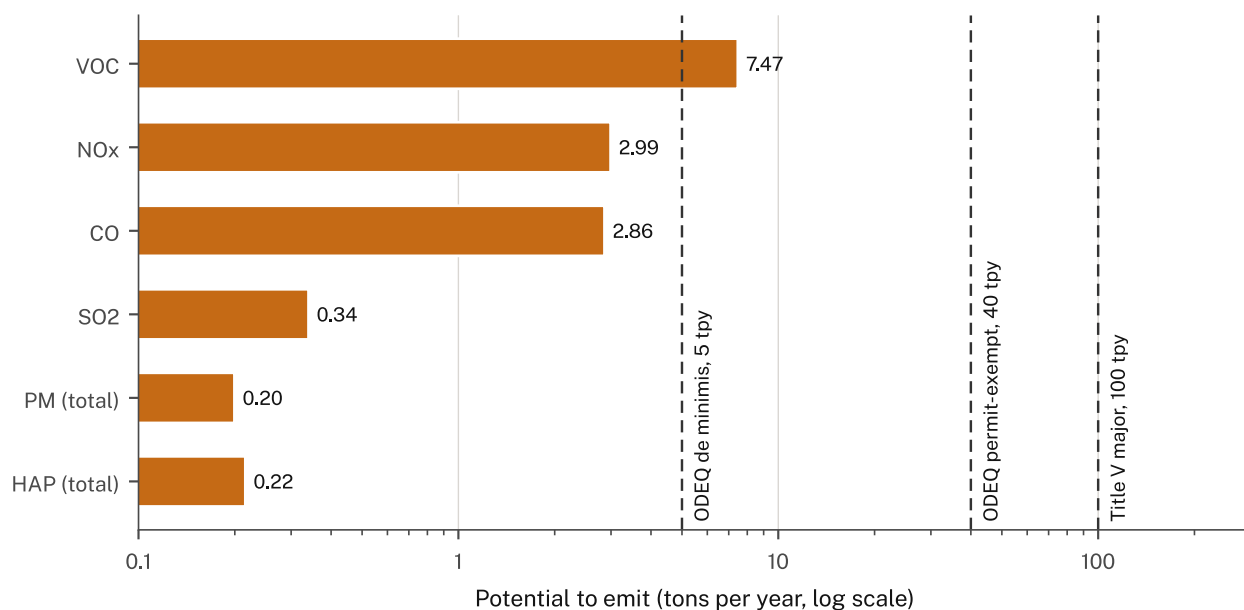
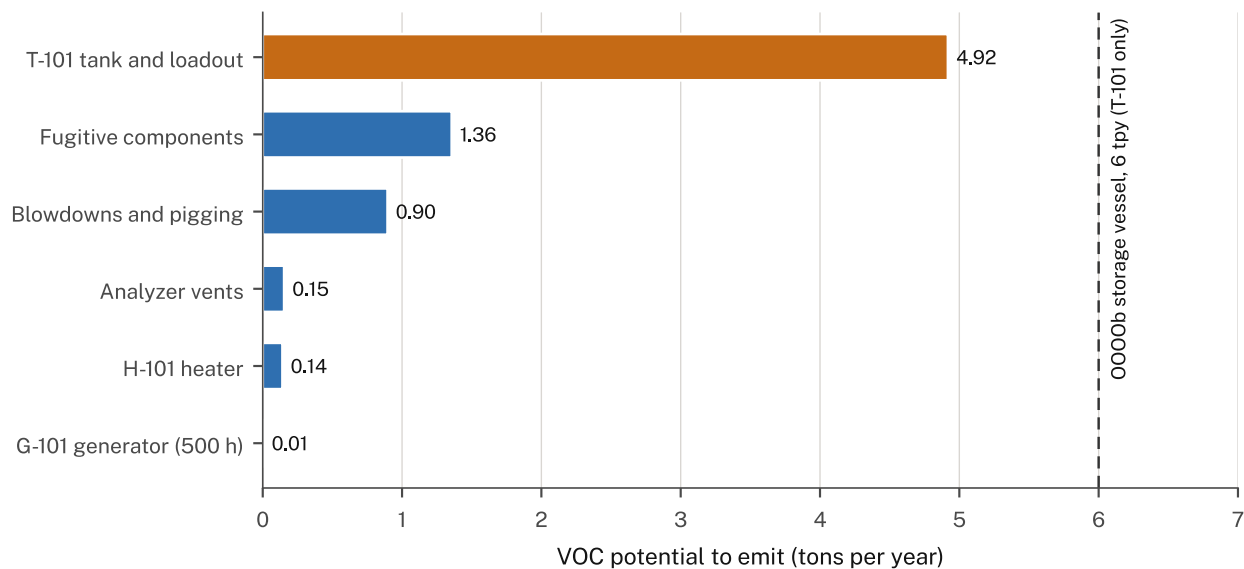


Figure 7-2. VOC Potential to Emit by Source



Note 1: T-101 at the recommended 350 bbl/yr enforceable throughput limit. The 6 tpy line applies to T-101 alone, not to the facility total.

TORUS draws the following conclusions:

1. The station is not a major source under Title V, Prevention of Significant Deterioration or the hazardous air pollutant program.
2. Every pollutant is below the 40 tpy level of 252:100-7, so the station should qualify as a permit-exempt facility or for the oil and gas permit-by-rule. VOC exceeds the 5 tpy de minimis level, so a de minimis claim is not available. The Owner should confirm the authorization route with the Department of Environmental Quality, as scheduled in REG-RPT-002.
3. T-101 stays below the OOOOb storage vessel threshold with an enforceable throughput limit of 350 bbl/yr, 12-month rolling (4.88 tpy), which is practical for the expected 52 to 260 bbl/yr of pigging liquids. The Owner shall record liquid loadouts monthly from haul tickets, cross-checked against level transmitter LT-191, and shall document the PTE determination within 30 days of startup (TBV against the rule). If the Owner's liquids data (HOLD H-20) show a sustained free-liquid rate that would exceed the limit, tank vapor control by an enclosed combustor with at least 95 % VOC destruction (bid alternate ALT-6 in CON-RPT-002) will be needed.
4. The generator shall be an EPA-certified engine meeting the JJJJ emergency standards, with a non-resettable hour meter and a 100 h/yr limit on non-emergency operation.
5. All valve actuators are electric or self-contained electro-hydraulic, so the station has no gas-driven process controllers or pumps. The analyzer vents are sample-system exhausts, not controllers; their treatment under OOOOb should be confirmed with the Department of Environmental Quality.

6. A meter station without compression is not a well site, centralized production facility or compressor station, so the OOOOb fugitive monitoring program is not expected to apply. Annual optical gas imaging surveys are still recommended as good practice.
7. Station GHG emissions of 3,393 t CO₂e/yr are well below the 25,000 t reporting threshold. Subpart W applies at the level of the Owner's basin-wide gathering and boosting facility, and this station's sources should be added to that inventory.

The following items remain open: the V-101 liquids rate (HOLD H-20), a pressurized liquid analysis to confirm the flash factor and flash gas composition (HOLD H-12), the certified generator data (HOLD H-15), and the pigging frequency and slug volume (HOLD H-16).

