

OWNER

Facility Siting and Spacing Review

Report



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N O T I C E

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ISSUE SUMMARY AND APPROVAL

This page records each issue of SAF-RPT-004. The preparer, reviewer and approver sign for each revision.

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1. INTRODUCTION

1.1. PURPOSE

This report reviews the layout of the () against the spacing criteria of GEN-DB-001, Basis of Design, and against the spacing commonly applied at gas handling facilities. It also checks the thermal radiation at grade if a release from vent stack VS-101 were ignited, the escape routes to the fence exits, and the location of the muster points used in SAF-RPT-005, Emergency Response Plan.

1.2. SCOPE

The review covers every item of equipment and building inside the station fence, the fence and gates, the Owner's lease tract and the receiving pipeline operator's right-of-way and trunkline to the north. The layout reviewed is plot plan MEC-DWG-001, Rev A, reproduced as Figure 2-1. Where the coordinates in the Basis of Design differ from the plot plan, the plot plan governs, because it is the layout that the piping, civil and electrical designs follow.

1.3. EXCLUSIONS

Area classification extents are set by ELE-RPT-001, Hazardous Area Classification, and are used here only as stated. Consequence modelling of releases other than the ignited vent, such as jet fires from flanges or vapor cloud dispersion across the site, is excluded; PRO-CAL-008, Blowdown, Vent Header and Vent Stack Calculation, recommends a detailed dispersion model for the engineer of record's review. Occupied-building blast assessment under API RP 752 is not required, because the station has no permanently occupied building.

2. BASIS

2.1. METHOD

TORUS measured every distance from the equipment footprints on the plot plan, in feet, with the origin at the south-west fence corner, X east and Y north. Each item is a rectangle; valves and small items are points. The shortest edge-to-edge distance between two footprints governs, because a release or an ignition source can be at any point of the item. Centerline distances understate the exposure and were not used.

Three items needed a definition beyond their footprint. The burner end of H-101 is taken as the east 6 ft of the heater (X 202 to 208 ft), where the burner, sight ports and fuel train are. The T-101 truck stand is the whole paved stand (X 25 to 45 ft, Y 116 to 136 ft), because a tank truck may stand anywhere on it. An earlier issue measured to the center of the stand and understated the distance to the vent stack by 10 ft. T-101 itself is 9 ft 6 in in diameter, centered at (30, 100) inside its 24 x 24 ft containment.

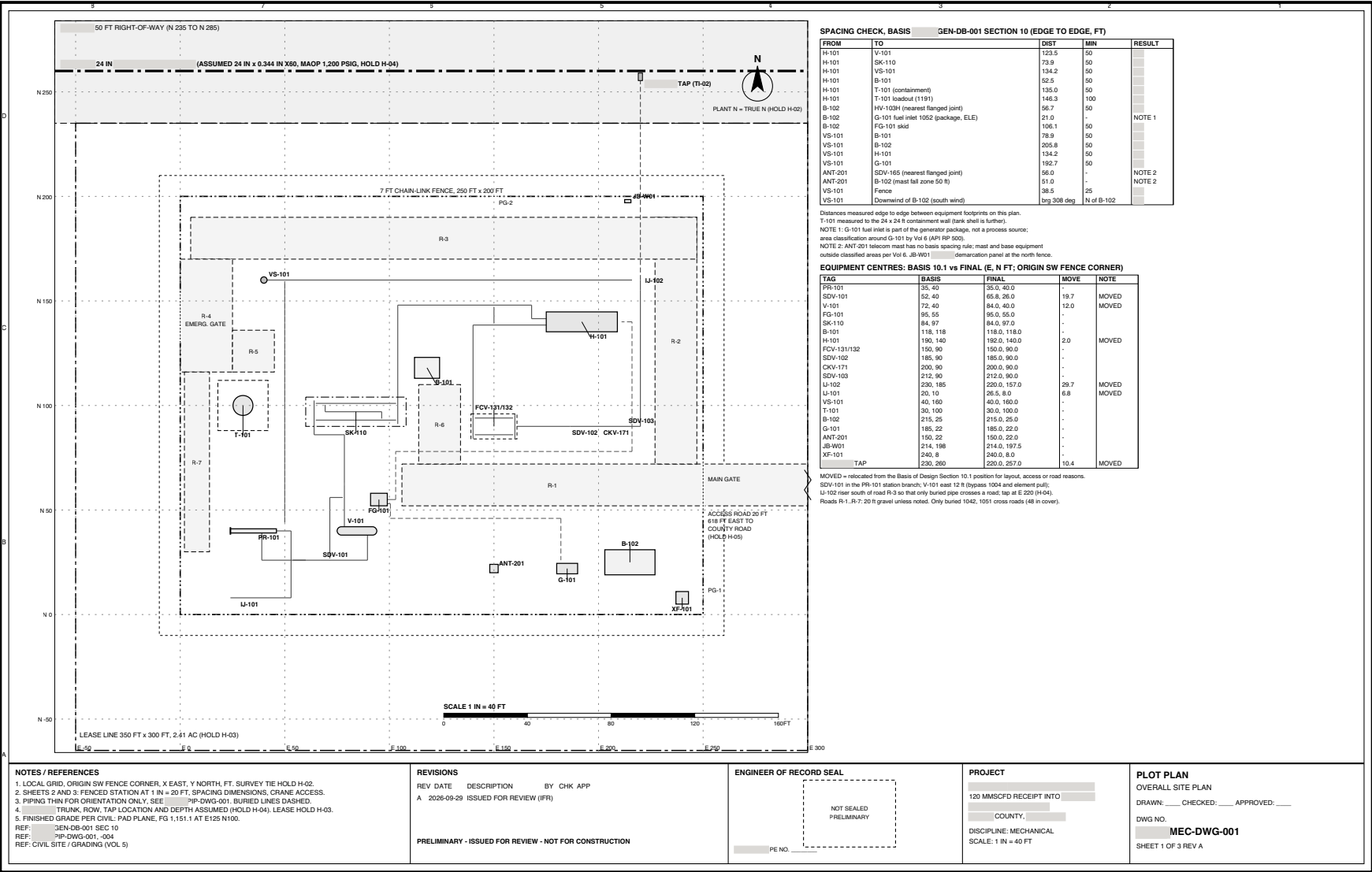
Release sources for the control building criterion are the flanged valves and equipment in gas service: the shutdown valves, the flow control valve station, check valve CKV-171, the meter skid, V-101, PR-101, the fuel gas skid FG-101 with its electric preheater E-161, the B-101 vents, the H-101 fuel train, VS-101 and the T-101 vent and truck stand. The outlet riser at IJ-102 is butt-welded with a monolithic insulating joint and no flanges, so it is reported but is not treated as a release source. The 1 in fuel branch to standby generator G-101 is a utility connection under NFPA 54 and is not treated as a process release source.

The distances were re-derived independently by sampling each footprint's perimeter at 0.25 ft, and every value in this report agreed to 0.1 ft.

2.2. PLOT PLAN

Figure 2-1 shows the layout reviewed. The process runs from the inlet and pig receiver in the south-west, through the separator and meter skid, to the heater, control valves and outlet in the east. The vent stack and liquids tank are in the north-west corner, away from the control building in the south-east.

Figure 2-1. Plot Plan, MEC-DWG-001



2.3. CRITERIA

The Basis of Design sets the following minimum distances:

- Fired equipment (H-101) 50 ft from the filter separator, meter skid, analyzer shelter, liquids tank and vent stack, and 100 ft from the tank truck loadout.
- Control building B-102 50 ft from every release source, so that it stays outside every classified area.
- Vent stack VS-101 50 ft from buildings and fired equipment, 25 ft from the fence, and north of B-102 so the prevailing summer south wind carries a vented plume away from the building.

Where the Basis of Design is silent, TORUS applied the spacing commonly used at gas facilities: 50 ft between fired equipment or engines and flanged gas valves, 50 ft between a vent stack and a truck stand or atmospheric tank, the NFPA 30 distances for the tank, the NFPA 37 clearance for the generator enclosure, and 50 ft between major equipment and a third-party pipeline. These checks are advisory. A shortfall is recorded with its justification rather than treated as a failure.

3. SPACING RESULTS

3.1. BASIS OF DESIGN CRITERIA

All 28 checks against the Basis of Design pass, as Table 3-1 shows. The tightest margins are H-101 to B-101, at 52.5 ft against 50 ft, and B-102 to the outlet valves CKV-171 and SDV-103, at 57.9 ft against 50 ft. Any change to the plot plan that moves H-101 west or south, B-101 east or north, or the outlet valves south shall be checked again before it is adopted.

Table 3-1: Spacing Against the Basis of Design

Ref	Item A	Item B	Edge distance, ft	Criterion, ft	Margin, ft	Result
S-01	H-101	V-101	123.5	50	73.5	Pass
S-02	H-101	SK-110 meter skid	73.9	50	23.9	Pass
S-03	H-101	T-101 containment	135.0	50	85.0	Pass
S-04	H-101	VS-101	134.2	50	84.2	Pass
S-05	H-101	B-101	52.5	50	2.5	Pass
S-06	H-101	T-101 truck stand	130.0	100	30.0	Pass
S-07	B-102	SDV-101	135.3	50	85.3	Pass
S-08	B-102	PR-101	157.2	50	107.2	Pass
S-09	B-102	V-101	109.2	50	59.2	Pass
S-10	B-102	FG-101	106.1	50	56.1	Pass
S-11	B-102	SK-110 meter skid	111.8	50	61.8	Pass
S-12	B-102	B-101	113.9	50	63.9	Pass
S-13	B-102	FCV station	67.6	50	17.6	Pass
S-14	B-102	SDV-102	60.1	50	10.1	Pass
S-15	B-102	CKV-171	57.9	50	7.9	Pass
S-16	B-102	SDV-103	57.9	50	7.9	Pass
S-17	B-102	Outlet riser IJ-102	119.0	50	69.0	Pass
S-18	B-102	VS-101	205.8	50	155.8	Pass
S-19	B-102	T-101 containment	170.8	50	120.8	Pass
S-20	B-102	T-101 truck stand	179.4	50	129.4	Pass
S-21	B-102	H-101 fuel train	107.0	50	57.0	Pass
S-22	VS-101	B-101	78.9	50	28.9	Pass
S-23	VS-101	B-102	205.8	50	155.8	Pass
S-24	VS-101	G-101	192.7	50	142.7	Pass

Ref	Item A	Item B	Edge distance, ft	Criterion, ft	Margin, ft	Result
S-25	VS-101	H-101	134.2	50	84.2	Pass
S-26	VS-101	Fence (west)	38.5	25	13.5	Pass
S-27	VS-101	B-102, northward offset	133.5	Any	133.5	Pass
S-35	E-161 on FG-101	B-102	110.6	50	60.6	Pass

Note 1: S-27 checks that VS-101 lies north of B-102, downwind in the prevailing summer south wind. The value is the north-south offset.

In the winter north wind, VS-101 is upwind of B-102, but the two are 205.8 ft apart, well beyond the distance at which an ignited vent could affect the building (Section 4).

3.2. COMMON PRACTICE

Table 3-2 gives the advisory checks. Four fall short: the heater burner end is 44 to 47 ft from the outlet valves, and the vent stack is 22.5 ft from the T-101 truck stand. Both are discussed below.

Table 3-2: Spacing Against Common Practice

Ref	Item A	Item B	Edge, ft	Criterion, ft	Margin, ft	Result	Basis of criterion
S-28	H-101 burner end	FCV station	56.8	50	6.8	Pass	Fired equipment to gas valves
S-29	H-101 burner end	SDV-102	46.7	50	-3.3	Advisory	Fired equipment to gas valves
S-30	H-101 burner end	CKV-171	44.2	50	-5.8	Advisory	Fired equipment to gas valves
S-31	H-101 burner end	SDV-103	44.2	50	-5.8	Advisory	Fired equipment to gas valves
S-32	H-101 burner end	FG-101	128.8	50	78.8	Pass	Fired equipment to gas valves
S-33	E-161 on FG-101	V-101	13.0	None	Not applicable	Pass	Listed for the classified location
S-34	E-161 on FG-101	SK-110 meter skid	35.0	None	Not applicable	Pass	Listed for the classified location
S-36	G-101	SDV-102	64.4	50	14.4	Pass	Engine to gas valves
S-37	G-101	SDV-103	67.5	50	17.5	Pass	Engine to gas valves

Ref	Item A	Item B	Edge, ft	Criterion, ft	Margin, ft	Result	Basis of criterion
S-38	G-101	FCV station	62.5	50	12.5	Pass	Engine to gas valves
S-39	G-101	B-102	13.0	5	8.0	Pass	NFPA 37, enclosure to building openings
S-40	XF-101	SDV-103	81.3	25	56.3	Pass	Transformer outside classified extents
S-41	XF-101	Outlet riser IJ-102	139.9	25	114.9	Pass	Transformer outside classified extents
S-42	T-101 shell	B-101	77.7	5	72.7	Pass	NFPA 30, tank to important building
S-43	T-101 shell	B-102	180.1	5	175.1	Pass	NFPA 30, tank to important building
S-44	VS-101	T-101 shell	53.9	50	3.9	Pass	Vent stack to atmospheric tank
S-45	VS-101	T-101 truck stand	22.5	50	-27.5	Advisory	Vent stack to truck
S-46	VS-101	PR-101	117.5	25	92.5	Pass	Vent stack clear of pig handling
S-47	VS-101	SK-110 meter skid	57.6	25	32.6	Pass	Vent stack clear of meter work area
S-48	T-101 shell	Fence (west)	25.2	15	10.2	Pass	Tank to fence
S-49	T-101 shell	Lease line	75.2	15	60.2	Pass	NFPA 30, property line
S-50	H-101	Fence (east)	42.0	25	17.0	Pass	Fired equipment to public access
S-51	North fence	Receiving pipeline right-of-way	35.0	Outside	35.0	Pass	Station outside the right-of-way
S-52	H-101	Trunkline centerline	115.2	50	65.2	Pass	Third-party pipeline

Ref	Item A	Item B	Edge, ft	Criterion, ft	Margin, ft	Result	Basis of criterion
S-53	VS-101	Trunkline centerline	98.5	50	48.5	Pass	Third-party pipeline
S-54	B-102	Trunkline centerline	229.0	50	179.0	Pass	Third-party pipeline
S-55	T-101 containment	Trunkline centerline	148.0	50	98.0	Pass	Third-party pipeline
S-56	B-101	Trunkline centerline	137.0	50	87.0	Pass	Third-party pipeline

Note 1: NFPA 30 Table 22.4.1.1(b) and NFPA 37 clause references are to be verified against the editions adopted by the authority having jurisdiction.

Note 2: The lease line distance assumes the fence is centered in the lease tract (HOLD H-03).

3.3. DISCUSSION

Heater burner end to the outlet valves (S-29 to S-31). The burner end of H-101 is 44.2 to 46.7 ft from SDV-102, CKV-171 and SDV-103, short of the 50 ft often applied between fired equipment and flanged gas valves. TORUS considered moving H-101 4 ft north and did not adopt it. The valves are not fired, storage or occupied equipment under the Basis of Design, every basis check passes, and the move would have shifted the heater foundation, coil piping and supports after the piping layout was set, for a gain of about 4 ft. The valves are in open air, where the classified extent around a valve or flange is a few feet (ELE-RPT-001), so the burner is outside every classified area. The shortfall is a margin matter, covered by the burner-end flame detector BE-213 and the station emergency shutdown (SAF-RPT-003, Fire and Gas Detection Philosophy). The justification shall be recorded in the Owner's management of change file.

Electric fuel gas preheater E-161 (S-33 to S-35). E-161 is both a small release source, through its flanges, and a potential ignition source, through its heated element. It is 13.0 ft from V-101. No separation is needed if E-161 is listed for its classified location with a temperature class of T3 or better, with TIC-161A and TSH-161B limiting the element temperature. TORUS Electrical is to confirm the listing. E-161 is 110.6 ft from B-102.

Standby generator G-101 (S-36 to S-39). G-101 is at least 62.5 ft from the nearest process release source and 13.0 ft from B-102, which meets the NFPA 37 clearance of 5 ft to building openings. Its exhaust shall discharge away from the B-102 air intake and door.

Liquids tank T-101 (S-42 to S-44, S-48, S-49). T-101 meets the NFPA 30 distances to buildings and to the lease line, and its shell is 25.2 ft from the west fence and 53.9 ft from VS-101. The tank's 16 in emergency vent EV-193 discharges vertically at the tank top.

Vent stack to the truck stand (S-45). The T-101 truck stand is 22.5 ft from VS-101, short of the 50 ft practice value for a truck engine near a vent. Moving the stand was considered and rejected, because the tank, the stand and the pig handling lane are fixed by the site grading and the tank location, and

relocating any of them would move the west road. Section 4 shows that an ignited vent would expose a driver on the stand to about 1,960 Btu/h·ft², above the 1,500 Btu/h·ft² limit for emergency action. The exposure is controlled by procedure: no truck loading while VS-101 is venting, no blowdown started while a truck is on the stand, and the driver attending with the engine off during loading.

Receiving pipeline right-of-way (S-51 to S-56). The north fence is 35 ft south of the right-of-way. All major equipment is at least 98.5 ft from the trunkline centerline. The buried outlet lateral from IJ-102 to the tap crosses the north road and enters the right-of-way; work there is under the receiving pipeline operator's crossing and excavation requirements (HOLD H-04).

4. VENT STACK RADIATION

4.1. METHOD

A relief valve discharge or manual blowdown through VS-101 could be ignited, for example by lightning. TORUS calculated the radiation at head height (6 ft) with the API 521 simple method, using the release rates and assumptions of PRO-CAL-008. The flame length is taken from the API 521 figure, the flame center is at mid-flame, and the flame is tilted by a 30 ft/s wind according to the ratio of wind speed to tip velocity. The worse of still air and wind is reported. Solar radiation of 317 Btu/h·ft² is added, and the transmissivity is taken as 1.0.

API 521, simple method for flare radiation

$$K = \frac{\tau F Q}{4\pi D^2}$$

where K is the radiation in Btu/h·ft², τ the transmissivity, $F = 0.20$ the fraction of heat radiated, Q the heat released on the lower heating value in Btu/h, and D the distance in ft from the flame center to the receptor.

An earlier screening placed the flame center at the stack tip and used the higher heating value with arbitrary release rates. That overstated the radiation near the stack and did not use the actual blowdown and relief rates, so it has been replaced by the method above. TORUS reproduced the PRO-CAL-008 radiation values at 0, 25, 50 and 100 ft independently to within 1 %.

4.2. CASES

Three cases were evaluated. The single-section blowdown of section S1 at its initial peak of 16,860 lb/h is the design case, because the operating procedure allows only one section to be blown down at a time. PSV-101 relieving at its rated capacity of 19,200 lb/h in a fire is the largest relief case. Simultaneous blowdown of sections S1, S2 and S3, at 35,890 lb/h, is shown only to explain why the procedure prohibits it.

4.3. RESULTS

Figure 4-1 plots the radiation at grade against the horizontal distance from the stack, and Table 4-1 gives it at each receptor. No point at grade reaches the 3,000 Btu/h·ft² escape-only limit in any case. For the single-section blowdown, the 1,500 Btu/h·ft² emergency-action contour extends 45 ft from the stack; for PSV-101 fire relief, 47 ft; for the prohibited simultaneous blowdown, 74 ft, which would reach the meter skid and the T-101 shell.

Figure 4-1. Radiation at Grade From an Ignited Vent at VS-101

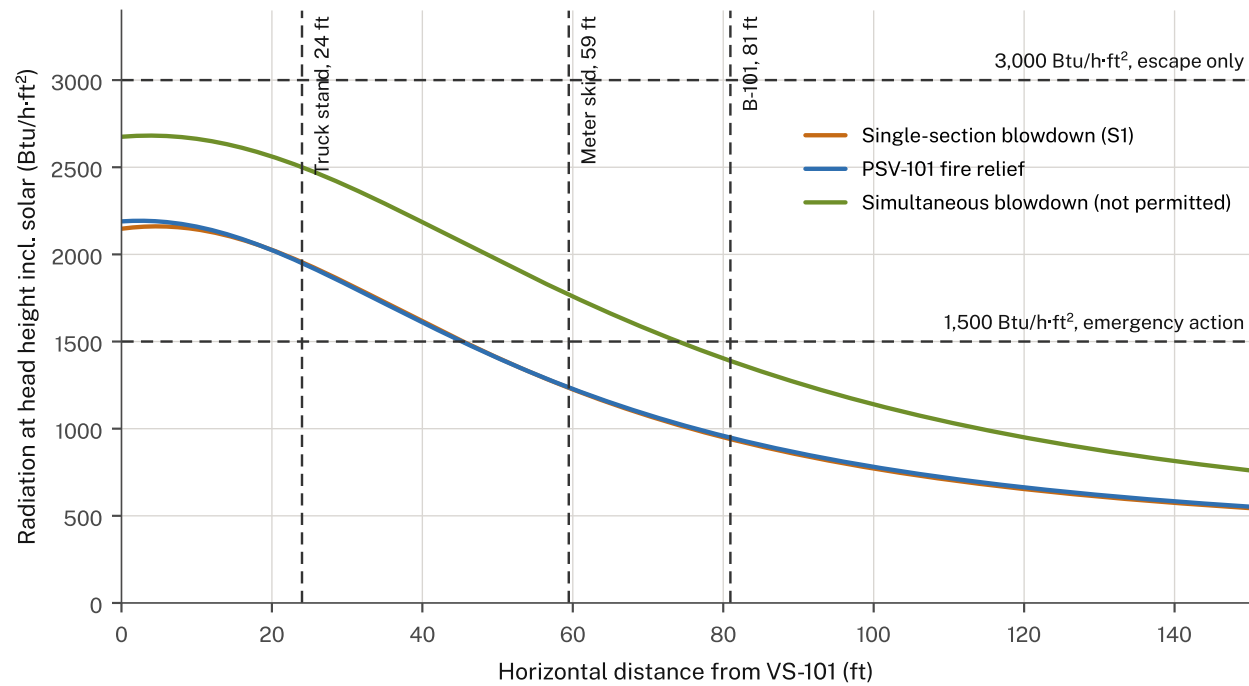


Table 4-1: Radiation at Receptors, Including Solar

Receptor	Horizontal distance from stack, ft	Single-section blowdown, Btu/h·ft ²	PSV-101 fire relief, Btu/h·ft ²	Simultaneous blowdown, Btu/h·ft ²
T-101 truck stand	24.0	1,960	1,990	2,500
West fence	40.0	1,620	1,650	2,180
Emergency gate (west)	40.4	1,610	1,640	2,170
T-101 shell	55.5	1,300	1,340	1,850
SK-110 meter skid	59.5	1,230	1,270	1,770
B-101	81.0	940	980	1,390
BDV-182 operating position	87.0	880	920	1,300
PR-101	119.0	660	690	960

Note 1: Distances are measured horizontally from the stack center to the nearest point of each receptor, so they differ slightly from the edge-to-edge distances in Table 3-1 and Table 3-2.

Note 2: API 521 design levels, including solar: 3,000 Btu/h·ft² where escape only is possible; 1,500 Btu/h·ft² where emergency action of a few minutes is needed with appropriate clothing; 500 Btu/h·ft² for continuous exposure.

The results lead to three findings. First, the 25 ft stack keeps the meter skid, B-101, the T-101 shell and the blowdown valve operating positions below 1,500 Btu/h·ft² for any permitted case, which confirms the stack height chosen in PRO-CAL-008. Second, the truck stand, the west fence line and the emergency gate lie inside the 1,500 Btu/h·ft² contour. The truck stand is controlled by the loading procedure (Section 3.3). The west fence and emergency gate are not work areas; during a blowdown or relief, people leave by the main gate and muster at MP-1, and the emergency gate is used only when the east side is blocked. Third, the prohibition on simultaneous blowdown is necessary, because it would bring the meter skid and the T-101 shell inside the 1,500 Btu/h·ft² contour.



5. EGRESS AND MUSTER POINTS

5.1. ESCAPE ROUTES

Table 5-1 gives the straight-line distance from each work area to its nearest and second-nearest fence exit. The exits are the main vehicle gate on the east fence (250, 62), the emergency vehicle gate on the west fence (0, 142), personnel gate PG-1 on the east fence (250, 9) and personnel gate PG-2 on the north fence (150, 200). Every work area has at least two exits in different directions, and no point is more than 133 ft in a straight line from its nearest exit.

Table 5-1: Distance to Fence Exits

Work area	Nearest exit	Distance, ft	Second exit	Distance, ft
PR-101 closure	Emergency gate (west)	104.8	PG-2 (north)	203.7
V-101	Emergency gate (west)	132.5	Main gate (east)	167.0
SK-110 meter skid	Emergency gate (west)	95.3	PG-2 (north)	122.3
B-101	PG-2 (north)	88.0	Emergency gate (west)	120.4
H-101 burner end	PG-2 (north)	81.4	Main gate (east)	90.0
FCV station	Main gate (east)	103.8	PG-2 (north)	110.0
SDV-103	Main gate (east)	47.2	PG-1 (east)	89.5
T-101 truck stand	Emergency gate (west)	38.5	PG-2 (north)	136.8
VS-101	Emergency gate (west)	43.9	PG-2 (north)	117.0
B-102	PG-1 (east)	38.5	Main gate (east)	50.9

Note 1: Distances are measured from the center of each work area to the center of each gate opening.

5.2. MUSTER POINTS

Two muster points are used, as set out in Table 5-2. MP-1, at (280, 62) on the access road outside the main gate, is the primary point. It lies crosswind of the process area in both the prevailing summer south wind and the winter north wind, and it is where responders arrive. MP-2, at (-45, 60) outside the west fence and inside the lease, is the alternate when an event blocks the east side. MP-2 is 131 ft from VS-101, where the radiation from any permitted vent case is below 700 Btu/h·ft² including solar.

Table 5-2: Muster Point Distances

From	MP-1 (east), ft	MP-2 (south-west), ft
VS-101	259.2	131.2
H-101 burner end	108.2	262.5
SK-110 meter skid	199.1	134.2
V-101	196.7	131.0

From	MP-1 (east), ft	MP-2 (south-west), ft
B-102	74.8	262.3
T-101 containment	252.9	85.0

Two windsocks, one on B-102 and one near the west emergency gate, shall be visible from both muster points, so the technician can choose the upwind point.



6. CONCLUSIONS AND NEXT STEP

TORUS draws the following conclusions:

1. The layout meets every spacing criterion of the Basis of Design. The tightest margins are H-101 to B-101 (2.5 ft) and B-102 to the outlet valves (7.9 ft); both shall be protected in any later change to the plot plan.
2. Two advisory shortfalls against common practice remain, and both are accepted with the reasons given: the heater burner end at 44 to 47 ft from the outlet valves, and the vent stack at 22.5 ft from the T-101 truck stand.
3. With the 25 ft stack and one section blown down at a time, an ignited vent keeps every work area except the truck stand below 1,500 Btu/h·ft². The truck stand is controlled by procedure. Simultaneous blowdown shall remain prohibited.
4. Every work area has two exits in different directions, and the muster points lie crosswind of the prevailing winds and outside the radiation contours.
5. Two corrections were made in this issue. The truck stand distance to VS-101 is 22.5 ft, not 32.7 ft, because the whole stand is now measured rather than its center. The vent radiation now follows the method and release rates of PRO-CAL-008 instead of a point-source screening with arbitrary rates.

The actions in Table 6-1 close the review. The next step is to carry SS-03 and SS-04 into the operating procedures and to confirm the lease tract boundary before the design is issued for construction. Two inputs remain open: the lease tract boundary (HOLD H-03, Owner) and the right-of-way and trunkline data (HOLD H-04, receiving pipeline operator).

Table 6-1: Recommendations

No.	Recommendation	By	Priority
SS-01	Record the justification for the H-101 burner end at 44 to 47 ft from SDV-102, CKV-171 and SDV-103 in the management of change file	Owner, TORUS Process Safety	Low
SS-02	Check any plot plan change against H-101 to B-101 (2.5 ft margin) and B-102 to the outlet valves (7.9 ft margin) before adopting it	TORUS Mechanical	High
SS-03	Keep the procedure of blowing down one section at a time, with a note at each blowdown valve	Owner operations	High
SS-04	No truck loading at the T-101 stand while VS-101 is venting, and no blowdown while a truck is on the stand	Owner operations	High
SS-05	Confirm E-161 is listed for its classified location with temperature class T3 or better	TORUS Electrical	Medium
SS-06	Route the G-101 exhaust away from the B-102 air intake and door	TORUS Electrical	Medium
SS-07	Confirm the lease tract boundary to finalize the NFPA 30 property-line distance (HOLD H-03)	Owner	Low

No.	Recommendation	By	Priority
SS-08	Install two windsocks, on B-102 and near the west emergency gate, visible from both muster points	TORUS Civil, TORUS Electrical	Medium

