13.1.2 Alarm summary

Table 13-2 summarizes ventilator alarms, including urgency, messages, and other information.

Table 13-2: Alarm summary

Base message	Urgency	Analysis message	Remedy message	Comments
AC POWER LOSS	Low	Operating on battery.	Prepare for power loss.	Power switch on, AC power not available, ventilator operating on BPS. BPS operating indicator turns on. Resets when AC power is restored.
	Medium	Operational time < 2 minutes.		
APNEA	Medium	Apnea ventilation. Breath interval > apnea interval.	Check patient & settings.	The set apnea interval has elapsed without the ventilator, patient, or operator triggering a breath. Resets when patient initiates 2 consecutive breaths. Possible dependent alarm: $\downarrow \dot{V}_{E\,TOT}$.
	High	Extended apnea duration or multiple apnea events.		

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
CIRCUIT DISCONNECT	High	No ventilation.	Check patient/ ventilator status.	Ventilator has recovered from unintended power loss lasting more than 5 minutes, detects circuit disconnect, and switches to idle mode; upper screen displays elapsed time without ventilator support. Resets when ventilator senses reconnection.
	High	No ventilation.	Check patient. Reconnect circuit.	Ventilator detects circuit disconnect and switches to idle mode; upper screen displays elapsed time without ventilator support. Resets when ventilator senses reconnection.
COMPLIANCE LIMITED V_T.	Low	Compliance compensation limit reached.	Inspired volume may be < set. Check patient and circuit type.	Compliance volume required to compensate delivery of a volume controlled breath exceeds the maximum allowed for 3 of the last 4 breaths.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
COMPRESSOR INOPERATIVE	Low	No compressor air. No operation during low AC power.	No remedy message displayed	Compressor ready indicator turns off. Resets when full AC power is restored.
	Low	No compressor air. No operation during AC power loss.		Ventilator turns off compressor. Resets when full AC power is restored.
	Low	No compressor air.		Compressor ready indicator turns off.
	Low	N/A	Replace compressor.	Alarm occurs when there are no LOW AC POWER and no AC POWER LOSS alarms for < 15 seconds AND time since power-on > 10 seconds.
DEVICE ALERT	Low	Breath delivery not affected.	Service required.	Background checks have detected a problem. Resets when ventilator passes EST.
	Low	Ventilation continues as set.	Replace & service ventilator.	
	Low	Breath delivery not affected. Compromised spirometry.		
	Low	Breath delivery not affected. Possible compromise of other functions.	Service required.	POST has detected a problem. Resets when ventilator passes POST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	Medium	Ventilation continues as set.	Replace & service ventilator.	Background checks have detected a problem. Accuracy of exhalation flow sensor temperature may be affected. Resets when ventilator passes EST.
	Medium	Ventilation continues as set.		Background checks have detected a problem. Accuracy of oxygen flow sensor temperature may be affected, ventilator using nominal value. Resets when ventilator passes EST.
	Medium	Breath delivery not affected. Compromised spirometry.		Background checks have detected a problem that has persisted for over 10 minutes. Resets when ventilator passes EST.
	Medium	Ventilation continues as set. Only O_2 available.		Background checks have detected a problem. Ventilator delivers 100% O_2. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	Medium	Breath delivery not affected. Compromised spirometry.	Check patient. Replace & service ventilator.	Background checks have detected a problem. Accuracy of exhalation flow sensor temperature may be affected. Resets when ventilator passes EST.
	Medium	Ventilation continues as set. Only air available.	Replace & service ventilator.	Background checks have detected a problem. Ventilator delivers 21% O_2. Resets when ventilator passes EST.
	High	Breath delivery not affected.		Background checks have detected a problem. Loss of GUI indicator lights. Setting changes disabled. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	High	Unable to determine status of breath delivery.	Check patient. Replace & service ventilator.	Background checks have detected a problem. Loss of GUI indicator lights. Resets when communication between GUI and BDU is re-established.
	High	Ventilation continues as set.	Replace & service ventilator.	Background checks have detected a problem. Loss of GUI indicator lights. Alarms, setting changes, and monitored data disabled. Resets when ventilator passes EST.
	High	Ventilation continues as set.	Replace & service ventilator.	Background checks have detected a problem. Setting changes, monitored data, and alarms disabled. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	High	Ventilation continues as set. Delivery/spiro may be compromised.	Replace & service ventilator.	Background checks have detected a problem. Setting changes not allowed. Resets when ventilator passes EST.
	High	Breath delivery not affected. Compromised spiro. Trig = pres.	Check patient. Replace & service ventilator.	Background checks have detected a problem and flow triggering was selected. Accuracy of exhalation flow sensor temperature may be affected. Resets when ventilator passes EST.
	High	Ventilation continues as set, except O_2% = 100.	Check patient. Replace & service ventilator.	Background checks have detected a problem. Ventilator delivers 100% O_2 instead of set O_2%. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	High	Ventilation continues as set. Compromised air delivery.	Replace & service ventilator. Check patient.	Background checks have detected a problem. Accuracy of air flow sensor temperature may be affected, ventilator using nominal value. Resets when ventilator passes EST.
	High	Ventilation continues as set. Compromised O_2 delivery.	Replace & service ventilator. Check patient.	Background checks have detected a problem. Accuracy of oxygen flow sensor temperature may be affected, ventilator using nominal value. Resets when ventilator passes EST.
	High	Power loss & recovery occurred with a pre-existing Device Alert.	Check Alarm log. EST required.	Background checks have detected a problem. Loss of GUI indicator lights. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
DEVICE ALERT (cont)	High	Ventilation continues as set, except O_2% = 21.	Check patient. Replace & service ventilator.	Background checks have detected a problem. Ventilator delivers 21% O_2 instead of set O_2%. Resets when ventilator passes EST.
	High	No ventilation. Safety Valve Open.	Provide alternate ventilation. Replace & service ventilator.	Background checks have detected a problem. Safety valve open indicator lights. Upper screen displays elapsed time without ventilator support. Resets when ventilator passes EST.
	High	No ventilation. Safety Valve Open.	Check patient. Replace & service ventilator.	
	High	No ventilation. Safety Valve Open.	Provide alternate ventilation. Replace & service ventilator.	Background checks have detected a problem. Ventilator inoperative and safety valve open indicators light. Message may not be visible. If possible, upper screen displays elapsed time without ventilator support. Resets when ventilator passes EST.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
$\uparrow P_{PEAK}$	Low	Last breath ≥ set limit.	Check patient circuit & ET tube.	Measured airway pressure ≥ set limit. Ventilator truncates current breath unless already in exhalation. Possible dependent alarms: $\downarrow V_{TE\ MAND}$, $\downarrow \dot{V}_{E\ TOT}$, $\uparrow f_{TOT}$.
	Medium	Last 3 breaths ≥ set limit.		
	High	Last 4 or more breaths ≥ set limit.		
$\downarrow P_{PEAK}$	Low	Last 2 breaths, pressure ≤ set limit.	Check for leaks.	Peak inspiratory pressure ≤ set limit. (Available only when Vent Type is NIV or during INVASIVE ventilation when Mandatory Type is VC+.)
	Medium	Last 4 breaths, pressure ≤ set limit.		
	High	Last 10 or more breaths, pressure ≤ set limit.		
$\uparrow O_2\%$	Medium	Measured $O_2\%$ > set for ≥ 30 s but < 2 min.	Check patient, gas sources, O_2 analyzer & ventilator.	The $O_2\%$ measured during any phase of a breath cycle is 7% (12% during the first hour of operation) or more above the $O_2\%$ setting for at least 30 seconds. (These percentages increase by 5% for 4 minutes following a decrease in the $O_2\%$ setting.) Alarm updated at 1-second intervals.
	High	Measured $O_2\%$ > set for ≥ 2 min.		

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
$\uparrow V_{TE}$	Low	Last 2 breaths ≥ set limit.	Check settings, changes in patient's R & C.	Exhaled tidal volume ≥ set limit. Alarm updated whenever exhaled tidal volume is recalculated. Possible dependent alarm: $\uparrow \dot{V}_{E\ TOT}$.
	Medium	Last 4 breaths ≥ set limit.		
	High	Last 10 or more breaths ≥ set limit.		
$\uparrow \dot{V}_{E\ TOT}$	Low	$\dot{V}_{E\ TOT}$ ≥ set limit for ≤ 30s.	Check patient & settings.	Expiratory minute volume ≥ set limit. Alarm updated whenever an exhaled minute volume is recalculated. Possible dependent alarm: $\uparrow V_{TE}$.
	Medium	$\dot{V}_{E\ TOT}$ ≥ set limit for > 30s.		
	High	$\dot{V}_{E\ TOT}$ ≥ set limit for > 120s.		

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
$\uparrow f_{TOT}$	Low	$f_{TOT} \geq$ set limit for $\leq$ 30s.	Check patient & settings.	Total respiratory rate $\geq$ set limit. Alarm updated at the beginning of each inspiration. Reset when measured respiratory rate falls below the alarm limit. Possible dependent alarms: $\downarrow V_{TE\ MAND}$, $\downarrow V_{TE\ SPONT}$, $\dot{V}_{E\ TOT}$.
	Medium	$f_{TOT} \geq$ set limit for > 30s.		
	High	$f_{TOT} \geq$ set limit for > 120s.		
$\uparrow P_{VENT}$	Low	1 breath $\geq$ limit.	Check patient circuit & ET tube.	Inspiratory pressure > 100 cmH_2O and mandatory type = VC or spontaneous type = TC or PA. Ventilator truncates current breath unless already in exhalation. Possible dependent alarms: $\downarrow V_{TE\ MAND}$, $\downarrow \dot{V}_{E\ TOT}$, $\uparrow f_{TOT}$.
	Medium	2 breaths $\geq$ limit.		
	High	3 or more breaths $\geq$ limit.		
INOPERATIVE BATTERY	Low	Inadequate charge or non-functional battery system.	Service/ replace battery.	BPS installed but not functioning. Resets when BPS is functional.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
INSPIRATION TOO LONG	Low	Last 2 spont breaths = IBW based T_I limit.	Check patient. Check for leaks.	Inspiratory time for spontaneous breath ≥ IBW-based limit. Ventilator transitions to exhalation. Resets when T_I falls below IBW-based limit. Active only when Vent Type is INVASIVE.
	Medium	Last 4 spont breaths = IBW based T_I limit.		
	High	Last 10 or more spont breaths = IBW based T_I limit.		
LOSS OF POWER	High			The ventilator power switch is on and there is insufficient power from AC and the BPS (if installed). There may not be a visual indicator for this alarm, but an independent audio alarm on the BDU sounds for at least 120 seconds. Alarm annunciation can be reset by turning power switch to off position.
LOW AC POWER	Low	Ventilator currently not affected.	Power interrupt possible.	Mains (AC) power has dropped below 80% of nominal for 1 second. Ventilator continues operation as close to settings as possible. Resets when there is no low AC power signal for 1 second.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
LOW BATTERY	Low	Operational time < 2 minutes.	Replace or allow recharge.	Resets when BPS has more than approximately 2 minutes of operational time remaining.
↓ O_2%	High	Measured O_2% < set O_2%.	Check patient, gas sources, O_2 analyzer & ventilator.	The O_2% measured during any phase of a breath cycle is 7% (12% during the first hour of operation) or more below the O_2% setting for at least 30 seconds, or below 18%. (These percentages increase by 5% for 4 minutes following an increase in the O_2% setting.) Alarm updated at 1-second intervals.
↓$V_{TE\ MAND}$	Low	Last 2 mand. breaths ≤ set limit.	Check for leaks, changes in patient's R & C.	Exhaled mandatory tidal volume ≤ set limit. Alarm updated whenever exhaled mandatory tidal volume is recalculated. Possible dependent alarms: ↑$\dot{V}_{E\ TOT}$, ↑f_{TOT} .
	Medium	Last 4 mand. breaths ≤ set limit.		
	High	Last 10 or more mand. breaths ≤ set limit.		

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
$\downarrow V_{TE\ SPONT}$	Low	Last 2 spont breaths ≤ set limit.	Check patient & settings.	Exhaled spontaneous tidal volume ≤ set limit. Alarm updated whenever exhaled spontaneous tidal volume is recalculated. Possible dependent alarms: $\downarrow \dot{V}_{E\ TOT}$, $\uparrow f_{TOT}$.
	Medium	Last 4 spont breaths ≤ set limit.		
	High	Last 10 or more spont breaths ≤ set limit.		
$\downarrow \dot{V}_{E\ TOT}$	Low	$\dot{V}_{E\ TOT}$ ≤ set limit for ≤ 30s.	Check patient & settings.	Total minute volume ≤ set limit. Alarm updated whenever exhaled minute volume is recalculated. Possible dependent alarms: $\downarrow V_{TE\ MAND}$, $\downarrow V_{TE\ SPONT}$, $\uparrow f_{TOT}$.
	Medium	$\dot{V}_{E\ TOT}$ ≤ set limit for > 30s.		
	High	$\dot{V}_{E\ TOT}$ ≤ set limit for > 120s.		

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
NO AIR SUPPLY	Low	Ventilation continues as set. Only O_2 available.	Check air source.	Operator-set O_2% equals 100%. Ventilator delivers 100% O_2. Resets if air supply connected.
	Low	Compressor inoperative. Ventilation continues as set. Only O_2 available.		
	High	Ventilation continues as set except O_2% = 100.	Check patient & air source.	Operator-set O_2% < 100%. Ventilator delivers 100% O_2 instead of set O_2%. Resets if air supply connected.
	High	Compressor inoperative. Ventilation continues as set, except O_2% = 100.		
NO AIR SUPPLY and NO O_2 SUPPLY	High	No ventilation. Safety Valve Open.	Provide alternate ventilation. Check both gas sources.	Safety valve open indicator lights. Upper screen displays elapsed time without ventilator support. Safety valve closes and indicator turns off if either gas supply is connected. Individual gas supply alarm resets when corresponding supply is connected.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
NO O_2 SUPPLY	Low	Ventilation continues as set. Only air available.	Check O_2 source.	Operator-set O_2% equals 21%. Resets if O_2 supply connected.
	High	Ventilation continues as set, except O_2% = 21.	Check patient & O_2 source.	Operator-set O_2% > 21%. Ventilator delivers 21% O_2 instead of set O_2%. Resets if oxygen supply connected.
O_2 SENSOR	Low	Ventilation unaffected.	O_2 sensor out of calibration/ failure. Press 100% O_2 CAL, replace or disable.	Background checks have detected a problem. Resets when operator successfully calibrates oxygen sensor, or disables oxygen sensor.
PROCEDURE ERROR	High	Patient connected before setup complete.	Provide alternate ventilation. Complete setup process.	Ventilator begins safety ventilation. Resets when ventilator startup procedure is complete.

Table 13-2: Alarm summary (cont)

Base message	Urgency	Analysis message	Remedy message	Comments
SCREEN BLOCK	Medium	Possible blocked beam or touch screen fault.	Remove obstruction or service ventilator.	Background checks have detected a problem. Resets when ventilator passes EST or when blockage is removed.
SEVERE OCCLUSION	High	Little/no ventilation.	Check patient. Provide alternate ventilation. Clear occlusions; drain circuit.	Ventilator enters occlusion status cycling (OSC) and upper screen displays elapsed time without ventilator support.