Application 2032: Constant Volume with Electric Reheat

Overview

In Application 2032, the controller provides a constant volume of air to the room during occupied periods, and a lower constant volume of air to the room during unoccupied periods. Reheat is provided by three stages of electric heat. In order for the application to work properly, the central air handling unit must provide pre-conditioned air to the terminal box. See Figure 2032-1 and Figure 2032-2.

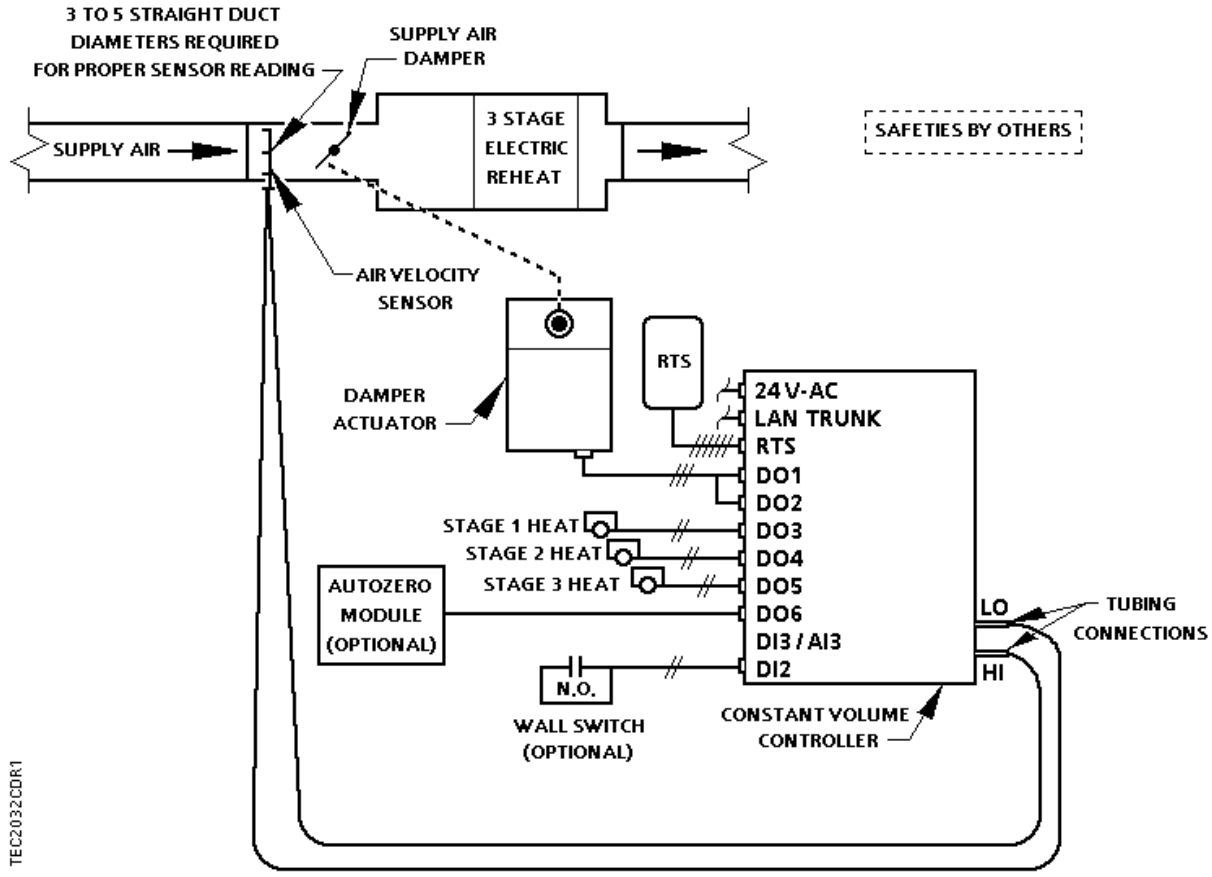
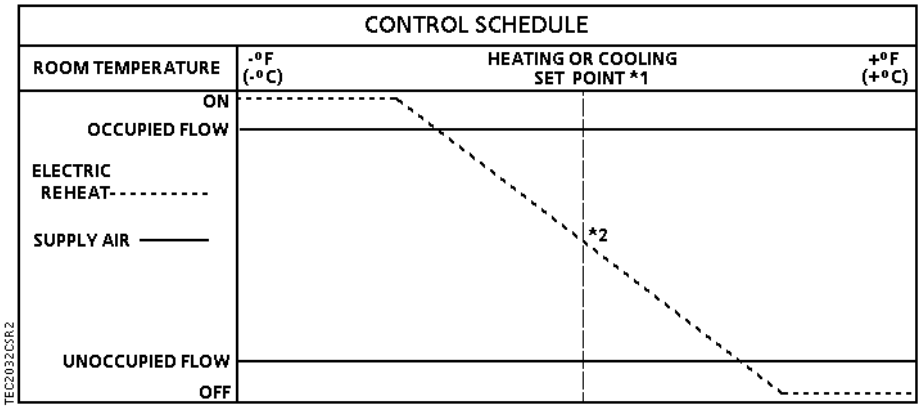


Figure 2032-1. Application 2032 Control Drawing.



1. See Sequence of Operation, *Control Temperature Setpoints*.
2. Electric reheat is time modulated. This allow it to be controlled proportionally rather than with deadbands.

Figure 2032-2. Application 2032 Control Schedule.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

- Night mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- None

Digital

- Autozero Module (optional)
- Damper actuator
- Stage 1 electric reheat or, 2-position heating valve
- Stage 2 electric reheat (optional)
- Stage 3 electric reheat (optional)

Ordering Notes

Constant Volume Controller – Electronic Output	540-103
Constant Volume Controller – Electronic Output with Autozero Module*	540-104*

*This controller is used in applications:

- Where it is not possible, due to operational restrictions, to calibrate the air velocity transducer by fully closing the damper (for example, clean rooms, laboratories),
- When a minimum position damper stop is used.

See *APOGEE Automation Configuration and Sizing Guidelines* on InfoLink for product numbers.

Autozero Module (optional)
Damper actuator
Terminal Equipment Controller room temperature sensor

Point Database

Table 2032-1 presents the point database information for Application 2032.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2032, "Constant Volume with Electric Reheat".

Control Temperature Setpoints

Depending on the controller's current operational mode (occupied or unoccupied), CTL STPT (Point 92) holds the value of one of the following setpoints:

NOTE: Application 2032 will not automatically switch between heating and cooling. If a seasonal switchover (for example, summer to winter) is to occur, the field panel must command HEAT.COOL (Point 5). This allows the controller to use the appropriate setpoints for the season.

Occupied Mode – CTL STPT holds the value of OCC CLG STPT (Point 6) in cooling mode and OCC HTG STPT (Point 7) in heating mode. If the room temperature sensor has a setpoint dial and STPT DIAL (Point 14) = YES, CTL STPT holds the value of RM STPT DIAL (Point 13).

If the setpoint dial is used and RM STPT DIAL < RM STPT MIN (Point 11), CTL STPT holds the value of RM STPT MIN. If RM STPT DIAL > RM STPT MAX (Point 12), CTL STPT holds the value of RM STPT MAX.

Unoccupied Mode – CTL STPT holds the value of UOC CLG STPT (Point 8) in cooling mode and UOC HTG STPT (Point 9) in heating mode. The setpoint dial is not used in unoccupied mode.

NOTE: The value of CTL TEMP (Point 78) is the same as ROOM TEMP (Point 4), unless CTL TEMP is overridden.

Occupied and Unoccupied Modes

The occupied/unoccupied status of the space is determined by the status of OCC.UNOCC (Point 29). The control of this point differs depending on whether the controller is monitoring the status of a wall switch or if the controller is connected to a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figure 2032-1 and Figure 2032-3), and WALL SWITCH (Point 18) = YES, the controller monitors the status of DI 2. When DI 2 (Point 24) is ON (the switch is closed), OCC.UNOCC will be set to OCC indicating that the controller is in occupied mode. When DI 2 is OFF (the switch is open), OCC.UNOCC will be set to UNOCC indicating that the controller is in unoccupied mode.

When WALL SWITCH = NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, if the controller is operating stand-alone, it stays in occupied mode all the time. If the controller is operating with centralized control (that is, connected to a field panel), the field panel can send an operator or PPCL command to override the status of OCC.UNOCC. See *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

Unoccupied Mode Override Switch

If an override switch is present on the room temperature sensor and a value (in hours) other than zero has been entered into OVRD TIME (Point 20), pressing the override switch will reset the controller to occupied operational mode for the amount of time that is set in OVRD TIME. The status of UNOCC OVRD (Point 21) changes to OCC. After the override time elapses, the controller returns to unoccupied mode and UNOCC OVRD changes back to UNOCC.

It is only when the controller is in unoccupied mode that the override switch on the room temperature sensor will have any effect on the controller.

Control Loops

Flow Loop – The flow loop maintains FLOW STPT by modulating the supply air damper point, DMPR COMD (Point 48). The flow loop maintains the airflow at either OCC FLOW (Point 32) or UNOCC FLOW (Point 31) depending on the value of OCC.UNOCC.

FLOW (Point 75) is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME (Point 35) is between 0 CFM (LPS) and OCC FLOW In the following text, this percentage is referred to as % flow.

- If AIR VOLUME = 0 CFM (LPS), FLOW is 0% flow.
- If AIR VOLUME = OCC FLOW, FLOW is 100% flow.

The FLOW STPT percentage that corresponds to UNOCC FLOW is calculated as: (UNOCC FLOW ÷ OCC FLOW) × 100% flow.

Example:

If UNOCC FLOW = 250 CFM, and OCC FLOW = 1000 CFM

then, in unoccupied mode the FLOW STPT

= (250 CFM ÷ 1000 CFM) × 100% flow
= 0.25 × 100% flow
= 25% flow

Since 25% of 1000 CFM = 250 CFM, the flow setpoint in unoccupied mode will be 25%.

UNOCC FLOW can be set less than or equal to, but not greater than OCC FLOW.

Temperature Loop – The temperature loop will modulate HTG LOOPOUT (Point 80) and control the electric reheat in order to maintain the room temperature in both heating and cooling modes.

Electric Reheat

CAUTION:

Verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are to be energized.

The heating loop controls up to three stages of electric reheat to maintain the room temperature. The electric reheat is time modulated using a duty cycle as shown in the following example.

Example

If the duty cycle is 10 minutes (STAGE TIME (Point 89) = 10 minutes) and the temperature loop is calling for 60% of heating (HTG LOOPOUT (Point 80) = 60%), for every 10-minute period, the stages of electric auxiliary heat cycle as follows:

	Stage 1: minutes		Stage 2: minutes		Stage 3: minutes	
	ON	OFF	ON	OFF	ON	OFF
With 1 stage of electric heat:	6	4	–	–	–	–
With 2 stages of electric heat:	10	0	2	8	–	–
With 3 stages of electric heat:	10	0	8	2	0	10

Electric Heat Interlock

The electric heat stages will be enabled as long as FLOW (Point 75) > EHEAT FLOW (Point 60). The electric heat stages will not be disabled (turned OFF) until (FLOW < EHEAT FLOW – 5%). Once disabled, FLOW must become greater than EHEAT FLOW before the electric heat stages will return to normal control.

CAUTION:

Do not set EHEAT FLOW to less than 5%; otherwise the electric heat interlock will be disabled.

Calibration

Calibration of the controller's internal air velocity transducer is periodically required to maintain accurate air velocity readings. CAL SETUP (Point 95) is set with the desired calibration option during controller start-up. Depending on the value of CAL SETUP, calibration may be set to take place automatically or manually. If CAL AIR (Point 94) = YES, calibration is in progress.

- For a controller used without an Autozero Module (CAL MODULE (Point 87) = NO), the damper is commanded closed to get a zero airflow reading during calibration.
- For a controller used with an Autozero Module (CAL MODULE = YES), calibration occurs without closing the damper.

NOTE: The first time after start-up or initialization, the controller will calibrate the dampers as if not using an Autozero Module, although the Autozero Module will be activated. All subsequent calibrations will use the Autozero Module only.

At the end of a calibration sequence, CAL AIR automatically returns to NO. A status of NO indicates that the controller is not in a calibration sequence.

The Autozero Module is enabled when it is wired to DO 6 and CAL MODULE (Point 87) is set to YES.

Damper Status Operation

Under normal operation DMPR STATUS (Point 84) reads CAL. However, when using an Autozero Module, it is possible after a period of operation for the calculated damper position point, DMPR POS (Point 49), to differ from the actual (physical) damper position.

If this occurs, the controller will *automatically* compensate for any difference by setting DMPR STATUS to RECAL which readjusts the value of DMPR POS. DMPR STATUS will be set to RECAL if all of the following conditions are true:

- DMPR POS = 100%
- Air velocity (AIR VOLUME (Point 35) ÷ DUCT AREA (Point 97)) > 200 FPM
- FLOW (Point 75) < FLOW STPT (Point 93)

- or -

- DMPR POS = 0%
- Air velocity (AIR VOLUME ÷ DUCT AREA) > 200 FPM
- FLOW > FLOW STPT

If DMPR STATUS has been changed to RECAL in response to one of the conditions described above, do one of the following:

- If flow is now being properly controlled, set DMPR STATUS to CAL and release it.
- If flow is still not being properly controlled (that is, one of the conditions described above is still present) or if it is important that the damper position be accurate, initialize the controller.

If these steps do not fix the problem of maintaining flow, a mechanical problem might exist.

Fail-safe Operation

If the air velocity sensor fails, the controller determines the status of FAIL MODE (Point 40) and positions the damper accordingly. If FAIL MODE = OPEN and the velocity sensor fails, the damper will open. If FAIL MODE = CLOSED (the default) and the velocity sensor fails, the damper will close.

If the room temperature sensor fails, the controller holds the last known temperature value.

Application Notes

1. If temperature swings in the room are excessive or there is trouble maintaining the room temperature setpoint, the temperature loop needs to be tuned. If FLOW (Point 75) is oscillating while FLOW STPT (Point 93) is constant, the flow loop requires tuning. See *APOGEE Automation Maintenance and Troubleshooting Procedures* on InfoLink for more information.

2. The Constant Volume Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. See the *Equipment Controllers* section in the *APOGEE Automation Start-up Procedures* on InfoLink for information on how to release the controller and its equipment to application control.

3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. DO 3 (HEAT STAGE 1), DO 4 (HEAT STAGE 2), and DO 5 (HEAT STAGE 3) control the stages of electric heat. If less than three stages are being controlled by the application, the DOs that are not used will be spare. If DO 6 is not used for an Autozero Module, it will be spare. See *APOGEE Automation Start-up Procedures* on InfoLink for more information.

Wiring Diagram

The point wiring for Application 2032 is shown in Figure 2032-3.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-relay module for any of the following:

- VA requirements higher than the maximum
- 110 or 220 Vac requirements
- DC power requirements
- Separate transformers used to power the load

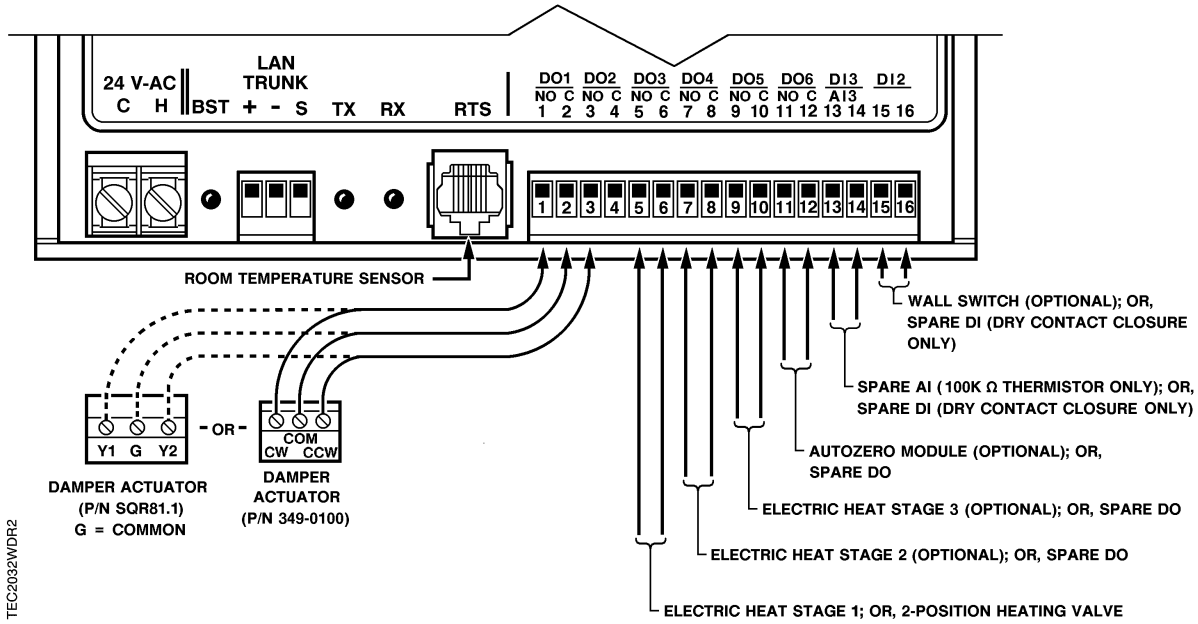


Figure 2032-3. Application 2032 Wiring Diagram.

Table 2032-1. Point Database for Application 2032.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99.000	–	1.000	0.000	–	–
02	APPLICATION	2092	–	1.000	0.000	–	–
{04}	ROOM TEMP	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{05}	HEAT.COOL	COOL	–	–	–	HEAT	COOL
06	OCC CLG STPT	70.000 (21.209)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
07	OCC HTG STPT	70.000 (21.209)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
08	UOC CLG STPT	65.000 (18.409)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
09	UOC HTG STPT	65.000 (18.409)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
11	RM STPT MIN	55.000 (12.809)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
12	RM STPT MAX	90.000 (32.409)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{13}	RM STPT DIAL	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
14	STPT DIAL	NO	–	–	–	YES	NO
{15}	AUX TEMP	74.000 (23.496)	DEG F (DEG C)	0.500 (0.280)	37.500 (3.056)	–	–
18	WALL SWITCH	NO	–	–	–	YES	NO
{19}	DI OVRD SW	OFF	–	–	–	ON	OFF
20	OVRD TIME	0.000	HRS	1.000	0.000	–	–
{21}	UNOCC OVRD	UNOCC	–	–	–	UNOCC	OCC
{24}	DI 2	OFF	–	–	–	ON	OFF
{25}	DI 3	OFF	–	–	–	ON	OFF
{29}	OCC.UNOCC	OCC	–	–	–	UNOCC	OCC
{31}	UNOCC FLOW	220.000 (103.818)	CFM (LPS)	4.000 (1.888)	0.000	–	–
{32}	OCC FLOW	2200.000 (1038.180)	CFM (LPS)	4.000 (1.888)	0.000	–	–

1. Points not listed are not used in this application
2. A single value in a column means that the value is the same in English units and in SI units.
3. Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2032-1. Point Database for Application 2032.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{35}	AIR VOLUME	0.000	CFM (LPS)	4.000 (1.888)	0.000	–	–
36	FLOW COEFF	1.000	–	0.010	0.000	–	–
40	FAIL MODE	CLOSED	–	–	–	CLOSED	OPEN
{41}	DO 1	OFF	–	–	–	ON	OFF
{42}	DO 2	OFF	–	–	–	ON	OFF
{43}	HEAT STAGE 1	OFF	–	–	–	ON	OFF
{44}	HEAT STAGE 2	OFF	–	–	–	ON	OFF
{45}	HEAT STAGE 3	OFF	–	–	–	ON	OFF
{46}	DO 6	OFF	–	–	–	ON	OFF
{48}	DMPR COMD	0.000	PCT	0.400	0.000	–	–
{49}	DMPR POS	0.000	PCT	0.400	0.000	–	–
51	MTR1 TIMING	95.000	SEC	1.000	0.000	–	–
56	DPR1 ROT ANG	90.000	–	1.000	0.000	–	–
58	MTR SETUP	0.000	–	1.000	0.000	–	–
59	DO DIR.REV	0.000	–	1.000	0.000	–	–
67	HTG P GAIN	10.000 (18.000)	–	0.250 (0.450)	0.000	–	–
68	HTG I GAIN	0.012 (0.022)	–	0.001 (0.002)	0.000	–	–
69	HTG D GAIN	0.000	–	2.000 (3.600)	0.000	–	–
70	HTG BIAS	0.000	PCT	0.400	0.000	–	–
71	FLOW P GAIN	0.250	–	0.050	0.000	–	–
72	FLOW I GAIN	0.018	–	0.001	0.000	–	–
73	FLOW D GAIN	0.000	–	2.000	0.000	–	–
74	FLOW BIAS	50.000	PCT	0.400	0.000	–	–
{75}	FLOW	0.000	PCT	0.250	0.0000	–	–
{78}	CTL TEMP	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–

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{80}	HTG LOOPOUT	0.000	PCT	0.400	0.000	–	–

Table 2032-1. Point Database for Application 2032.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{81}	AVG HEAT OUT	0.000	–	2.000	0.000	–	–
82	STAGE MAX	90.000	PCT	0.400	0.000	–	–
83	STAGE MIN	10.000	PCT	0.400	0.000	–	–
{84}	DMPR STATUS	CAL	–	–	–	RECAL	CAL
87	CAL MODULE	NO	–	–	–	YES	NO
88	STAGE COUNT	3.000	–	1.000	0.000	–	–
89	STAGE TIME	10.000	MIN	1.000	0.000	–	–
{91}	TOTAL VOLUME	0.000	CF (L)	4.000 (113)	0.000	–	–
{92}	CTL STPT	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{93}	FLOW STPT	0.000	PCT	0.250	0.000	–	–
{94}	CAL AIR	NO	–	–	–	YES	NO
95	CAL SETUP	4.000	–	1.000	0.000	–	–
96	CAL TIMER	12.000	HRS	1.000	0.000	–	–
97	DUCT AREA	1.000 (0.093)	SQ. FT (SQ M)	0.025 (0.002)	0.000	–	–
98	LOOP TIME	5.000	SEC	1.000	0.000	–	–
99	ERROR STATUS	–	–	–	–	–	–

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