31.25 Steam enters a 65% efficient turbine at $1000°F$ and $1200psia$ and exits at $250psia$. What is the enthalpy of the exiting steam?

A. $1160\frac{Btu}{lb}$

B. $1230\frac{Btu}{lb}$

C. $1300\frac{Btu}{lb}$

D. $1370\frac{Btu}{lb}$

Consider the entering steam as State 1, and the exiting steam as State 2.

Use the Properties of Superheated Steam table to obtain the enthalpy and entropy for State 1.

$$T_1 = 1000°F$$

$$P_1 = 1200psia$$

$$h_1 = 1500\frac{Btu}{lb}$$

$$s_1 = 1.63\frac{Btu}{lb°R}$$

Temporarily assume the expansion process is isentropic in order to find the *ideal* change in enthalpy for a 100% efficient process. Take the entropy for State 2 as being equal to the entropy of State 1. The exit pressure at State 2 is known. The Properties of Superheated Steam table does not have a table for 250 psia, therefore it is necessary to interpolate between the 200 psia and 300 psia table. Reasonable estimation is recommended to save time, even at the expense of some precision.

$$s_2 = s_1 = 1.63\frac{Btu}{lb°R}$$

$$P_2 = 250psia$$

$P\,[psia]$	$h\,\left[\frac{Btu}{lb}\right]$
200	1275
250	1297
300	1318

Calculate the *ideal* change in enthalpy.

$$\Delta h_{ideal} = 1500\frac{Btu}{lb} - 1297\frac{Btu}{lb} = 203\frac{Btu}{lb}$$

Relax the assumption of isentropic expansion and use the efficiency to calculate the *actual* change in enthalpy.

$$\eta = \frac{\Delta h_{actual}}{\Delta h_{ideal}}$$

$$\Delta h_{actual} = \eta \Delta h_{ideal} = 0.65\,(203) = 132\frac{Btu}{lb}$$

Determine the *actual* enthalpy at State 2. (Distinguish this from the previously determined *ideal* enthalpy at State 2.)

$$\Delta h_{actual} = h_1 - h_2 = 132\frac{Btu}{lb}$$

$$h_2 = h_1 - \Delta h_{actual} = 1500\frac{Btu}{lb} - 132\frac{Btu}{lb} = 1368\frac{Btu}{lb}$$

Answer D