Analysis of end of expansion and exhaust temperatures:

Inlet temperature at $T := 850$
with an expansion ratio: $X := 27$
Analyzed over a pressure range of $p_l := 850$PSIA to $p_h := 4500$PSIA

Setup steam calculations to produce first 7 properties: $ST\_limit(7) = 7$
0 pressure, 1 temperature, 2 specific volume, 3 specific internal energy,
4specific enthalpy, 5 specific entropy, 6 quality.

$\boldsymbol{J} \equiv 778.169262266$ conversion factor ft lb (work) per BTU

Set up number of points to analyze and generate an array of pressure values.

$N := 32$ Number of points analyzed

$i := 0 .. N - 1$ Mathcad array index 0 to N-1

$P_i := p_l + \frac{p_h - p_l}{N - 1} \cdot i$ Generates an N element array of pressure values

Generate an array of steam inlet steam states.

$P1_i := ST\_ptdata\left(P_i, T, 1, 1\right)$ initial inlet steam state

First and last inlet steam state points:

$$P1_0 = \begin{pmatrix} 850 \\ 850 \\ 0.8625 \\ 1289.98984 \\ 1425.65509 \\ 1.61234 \\ 1 \end{pmatrix} \qquad P1_{N-1} = \begin{pmatrix} 4500 \\ 850 \\ 0.10467 \\ 1128.16472 \\ 1215.3286 \\ 1.29977 \\ 1 \end{pmatrix}$$

Pressure
Temperature
Specific volume
Specific Internal Energy
Specific Enthalpy
Specific Entropy
Qualty

We have to solve the isentropic expansion for ending pressure. An initial guess of $p_g := 15$ is used.
The root function solves for a state point having X time the specific volume of state point 1

$p_i := root\left[ST\_ptdata\left[p_g, \left(P1_i\right)_5, 5, 1\right]_2 - \left(P1_i\right)_2 \cdot X, p_g\right]$ Solve for end of expansion pressure.

$P2_i := ST\_ptdata\left[p_i, \left(P1_i\right)_5, 5, 1\right]$ Now calculate expansion states array

Following the exhaust state is figured two diferent ways. There is a debate on how exhaust state should be figured. My theodynamic books are contridictory on this also. On one hand we have the conservation of energy law. The engine should reject all energy not converted to work. On the other hand we have valve processes arestated as being throttling processes. Here I just figured it both ways. The one quistion I have: Is constant pressure work a conversion of heat to work?. A motor does no conversion and this process would then be a motor. The work was produced in the boiler as the steam was generated and heated then utilized in a motor. Maybe.

This first analysis treats valves as a throttling process (no change in enthalpy)

$Hx_i := (P2_i)_4$ Exhaust enthalpy .. same as end of expansion enthalpy

$P3_i := \text{ST\_ptdata}(15, Hx_i, 4, 1)$ Exhaust state.

initial pressure $(P1_i)_0 =$	expansion pressure $(P2_i)_0 =$	expansion temperature $(P2_i)_1 =$	exhaust temperature $(P3_i)_1 =$	exhaust quality $(P3_i)_6 =$
850	15.29104	214.00814	213.03421	0.90223
967.74194	17.62474	221.3082	213.03421	0.89994
1085.48387	20.00223	227.96618	213.03421	0.89762
1203.22581	22.42453	234.11019	213.03421	0.89524
1320.96774	24.89156	239.83077	213.03421	0.89282
1438.70968	27.40414	245.19776	213.03421	0.89035
1556.45161	29.96259	250.26396	213.03421	0.88783
1674.19355	32.57323	255.08168	213.03421	0.88526
1791.93548	35.23149	259.67416	213.03421	0.88263
1909.67742	37.94111	264.07391	213.03421	0.87995
2027.41935	40.70368	268.30431	213.03421	0.87721
2145.16129	43.52074	272.38483	213.03421	0.8744
2262.90323	46.39374	276.33176	213.03421	0.87153
2380.64516	49.33677	280.17504	213.03421	0.86862
2498.3871	52.33582	283.90556	213.03421	0.86563
2616.12903	55.40015	287.54329	213.03421	0.86256
2733.87097	58.53265	291.09815	213.03421	0.85943
2851.6129	61.73639	294.57895	213.03421	0.85622
2969.35484	65.01457	297.99355	213.03421	0.85293
3087.09677	68.37058	301.34898	213.03421	0.84956
3204.83871	71.8079	304.65155	213.03421	0.8461
3322.58065	75.33012	307.90693	213.03421	0.84255
3440.32258	78.96806	311.14389	213.03421	0.83891
3558.06452	82.68543	314.33073	213.03421	0.83517
3675.80645	86.50452	317.48786	213.03421	0.83131
3793.54839	90.43058	320.61965	213.03421	0.82735
3911.29032	94.46894	323.73003	213.03421	0.82326
4029.03226	98.62496	326.82249	213.03421	0.81906
4146.77419	102.90387	329.90002	213.03421	0.81472
4264.51613	107.31056	332.96503	213.03421	0.81026
4382.25806	111.84943	336.01934	213.03421	0.80567
4500	116.52413	339.06405	213.03421	0.80094

This second analysis figures the exhaust enthalpy to the conservation of energy law.
heat rejected = heat_in - work_out

$$Hx_i := \left(P2_i\right)_4 - \left[\left(P2_i\right)_0 - 15\right]\cdot\left(P2_i\right)_2\cdot\frac{144}{\boldsymbol{J}}$$

$$P3_i := ST\_ptdata\left(15, Hx_i, 4, 1\right)$$

Exhaust enthalpy .. end of expansion enthalpy - const pressure work P V / J
Exhaust state.

initial pressure $\left(P1_i\right)_0 =$	expansion pressure $\left(P2_i\right)_0 =$	expansion temperature $\left(P2_i\right)_1 =$	exhaust temperature $\left(P3_i\right)_1 =$	exhaust quality $\left(P3_i\right)_6 =$
850	15.29104	214.00814	213.03421	0.90094
967.74194	17.62474	221.3082	213.03421	0.88979
1085.48387	20.00223	227.96618	213.03421	0.88053
1203.22581	22.42453	234.11019	213.03421	0.87259
1320.96774	24.89156	239.83077	213.03421	0.86561
1438.70968	27.40414	245.19776	213.03421	0.85934
1556.45161	29.96259	250.26396	213.03421	0.8536
1674.19355	32.57323	255.08168	213.03421	0.84829
1791.93548	35.23149	259.67416	213.03421	0.84331
1909.67742	37.94111	264.07391	213.03421	0.83858
2027.41935	40.70368	268.30431	213.03421	0.83405
2145.16129	43.52074	272.38483	213.03421	0.82968
2262.90323	46.39374	276.33176	213.03421	0.82543
2380.64516	49.33677	280.17504	213.03421	0.82129
2498.3871	52.33582	283.90556	213.03421	0.81722
2616.12903	55.40015	287.54329	213.03421	0.8132
2733.87097	58.53265	291.09815	213.03421	0.80922
2851.6129	61.73639	294.57895	213.03421	0.80527
2969.35484	65.01457	297.99355	213.03421	0.80131
3087.09677	68.37058	301.34898	213.03421	0.79736
3204.83871	71.8079	304.65155	213.03421	0.79339
3322.58065	75.33012	307.90693	213.03421	0.78939
3440.32258	78.96806	311.14389	213.03421	0.78537
3558.06452	82.68543	314.33073	213.03421	0.78129
3675.80645	86.50452	317.48786	213.03421	0.77716
3793.54839	90.43058	320.61965	213.03421	0.77297
3911.29032	94.46894	323.73003	213.03421	0.76871
4029.03226	98.62496	326.82249	213.03421	0.76438
4146.77419	102.90387	329.90002	213.03421	0.75996
4264.51613	107.31056	332.96503	213.03421	0.75546
4382.25806	111.84943	336.01934	213.03421	0.75086
4500	116.52413	339.06405	213.03421	0.74617