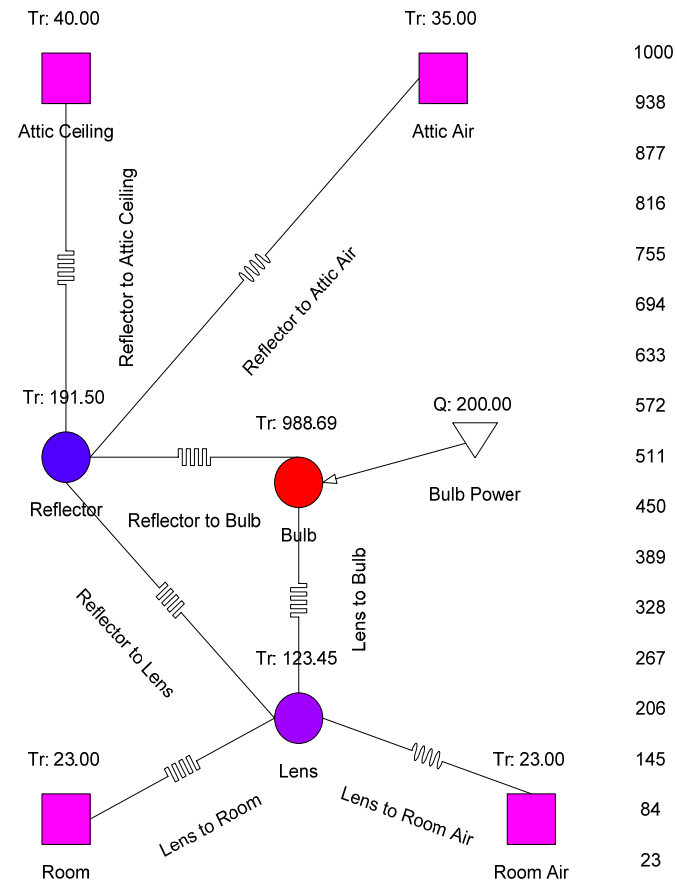
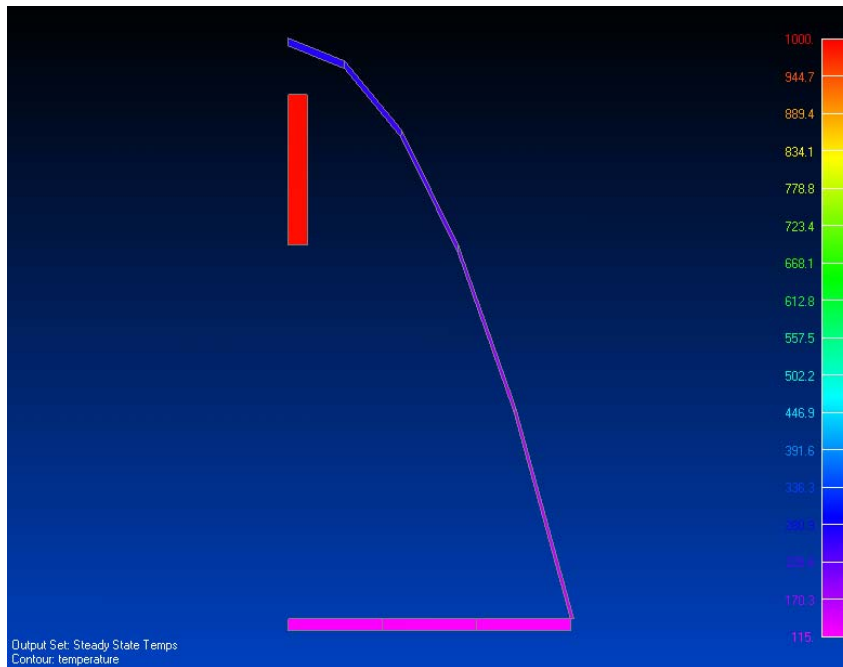


Thermal Analysis of Recessed Halogen Light Fixture



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Description of Problem

- A simplified model of halogen light fixture consisting of bulb, parabolic reflector and lens.
- Fixture is recessed in room ceiling.
- Assumed 200 watts of Infrared radiative power does not exit the fixture through the lens.
- Convection to attic and room air.
 - McAdams Relations used. Attic air at 35°C, room air at 23°C.
- Radiation to attic and room surfaces.
 - All surfaces assumed to have emissivity = 1.
 - All surfaces are opaque.
 - Attic surfaces at 40°C
 - Room surfaces at 23°C.

Two Modeling Methods

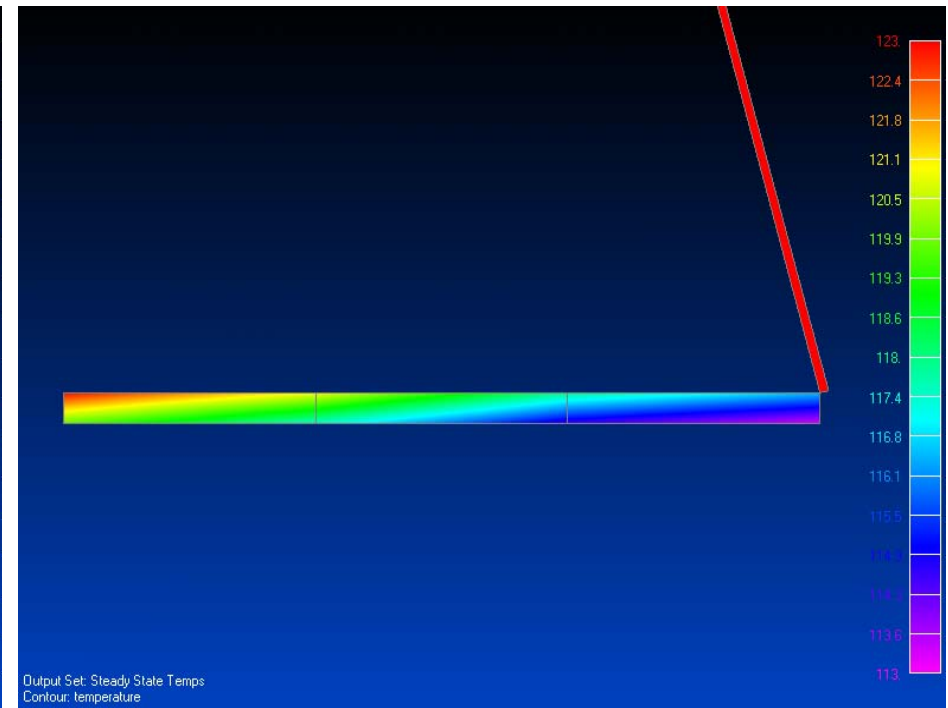
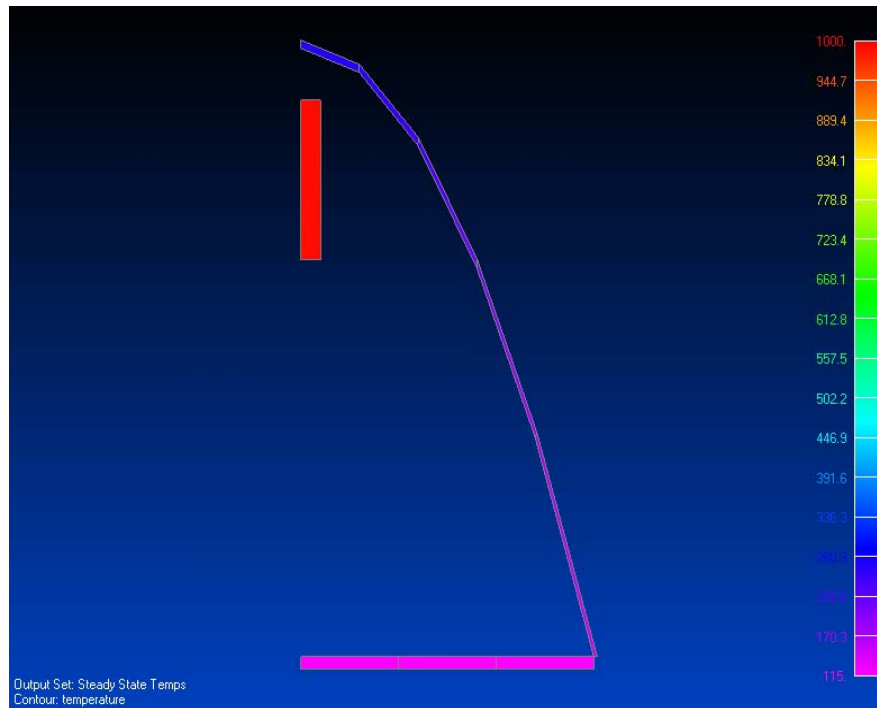
1. Nevada/Femap used to compute view factors and radiation conductors.
2. Schematic Visio model to obtain coarse results.

Nevada/Femap Model

- Parabolic reflector modeled as 5 conical frustums.
- Axisymmetric elements used.
- Model consists of 24 nodes.
- Sinda/g skeleton file used to compute convection conductors using McAdams relations.

```
BCD 3VARIABLES 1
C take average temperatures for McAdams
F  XLENS=DOT_PRODUCT(T(NR(30):NR(33)),C(NR(30):NR(33)))/
F  & SUM( C(NR(30):NR(33)) )
F  XLENSL = 0.075 !characteristic lens length
C Lens convection conductors
F  G(55:58)=A(8:11)*1.32*(ABS(23.0-XLENS)/XLENSL)**0.25
```

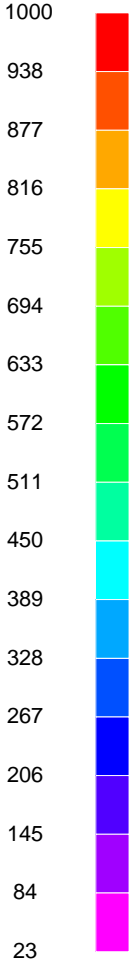
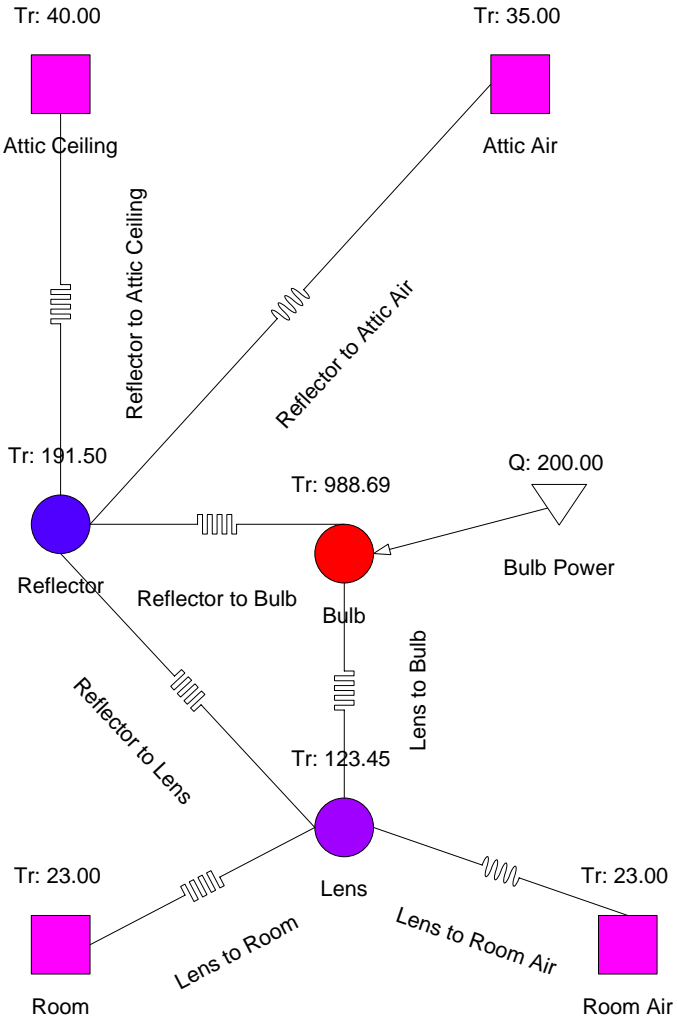
Nevada/Femap Post Processing



Schematic Model

- Model consists of only 3 nodes for the light fixture: one each for the reflector, bulb and lens.
- Preliminary model built using estimates for view factors later refined with view factors from Nevada results.

Schematic Model Built in Visio



McAdams relations update convection conductors.

```

BCD 3VARIABLES 1
McAdams Formulas
M G4=0.0177*1.32*(ABS(T2-T5)/0.075)**0.25 $Lens to Air
M G5=0.051*1.42*(ABS(T1-T7)/0.178)**0.25 $Reflector to Air
END
    
```

Temperature Results with Convection

	Reflector (°C)	Bulb (°C)	Lens (°C)
Schematic	192	989	123
Nevada/Femap	193	991	115

Temperature Results without Convection*

	Reflector (°C)	Bulb (°C)	Lens (°C)
Schematic	235	991	179
Nevada/Femap	236	994	169

*Covering the fixture with attic insulation would result in even more drastic rise in temperatures.

Heat Flow Results

Radiative Heat Flow (Watts)		Convective Heat Flow (Watts)	
Schematic/NevadaFemap		Schematic/NevadaFemap	
Reflector/Attic	107/110	Reflector/Attic	62/62
Lens/Room	17/15	Lens/Room	14/13

Conclusion

Since more than 80% of the heat flow is to the attic the fixtures must not be covered with insulation to ensure safe performance.