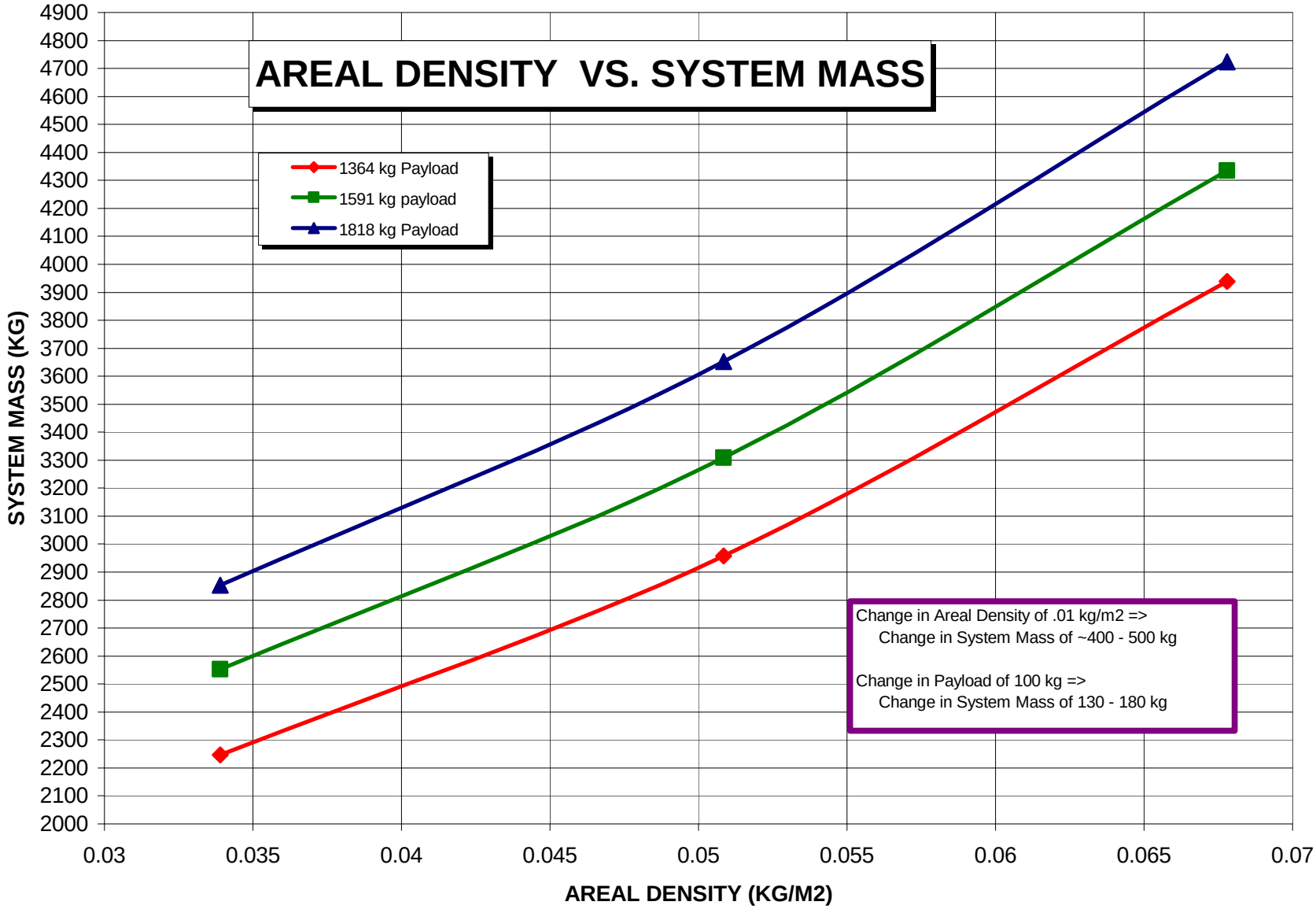
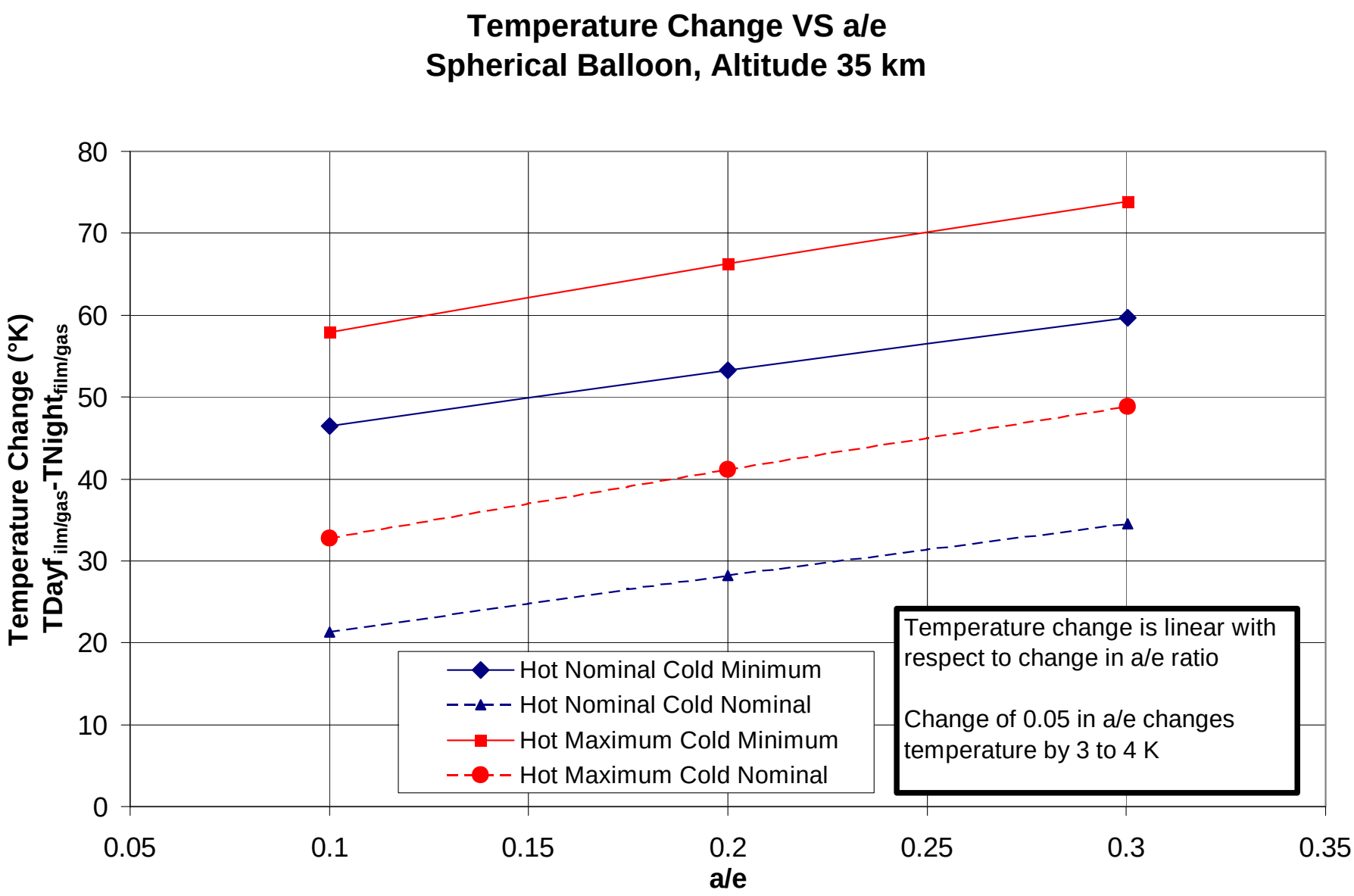
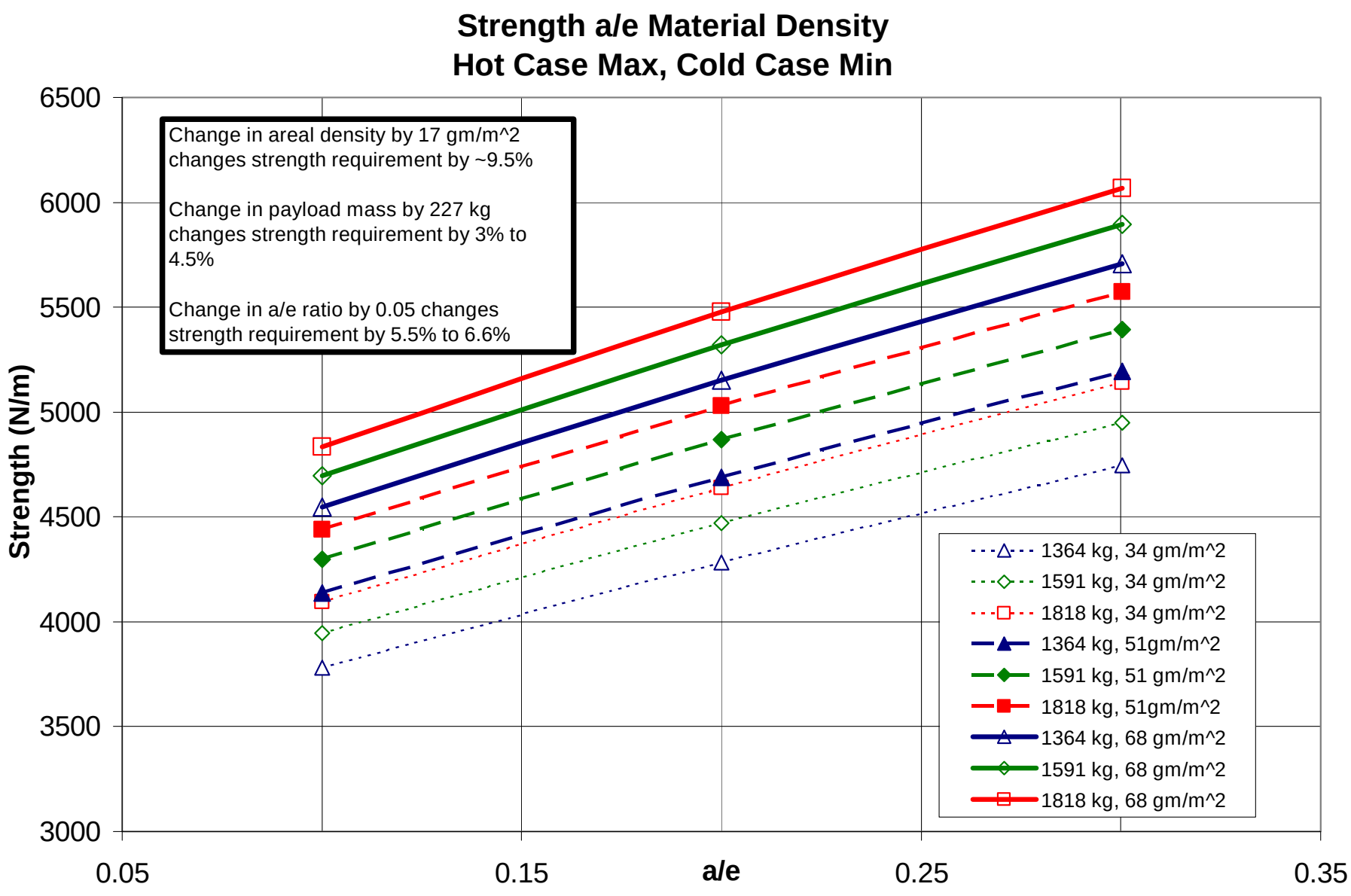
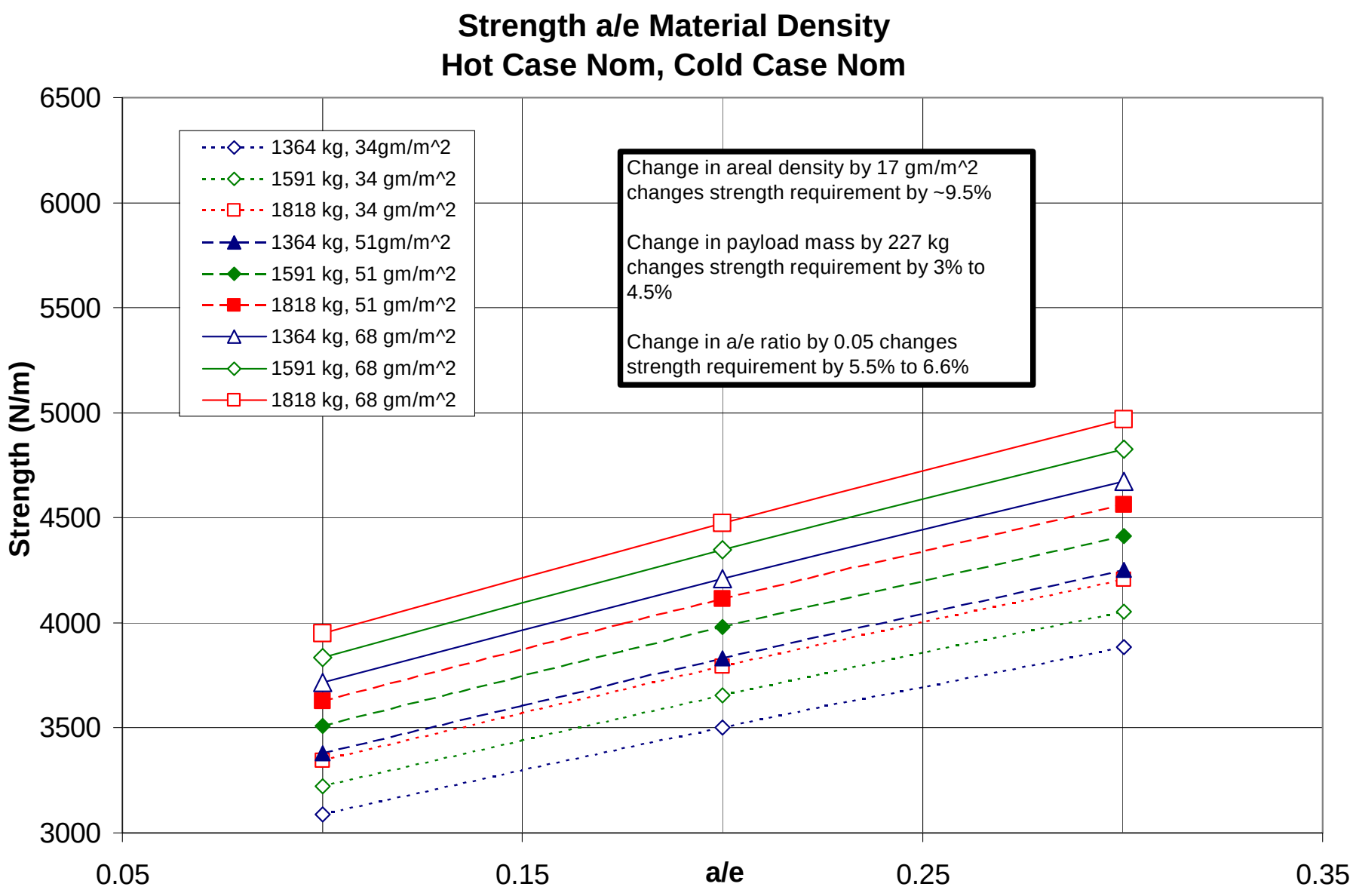
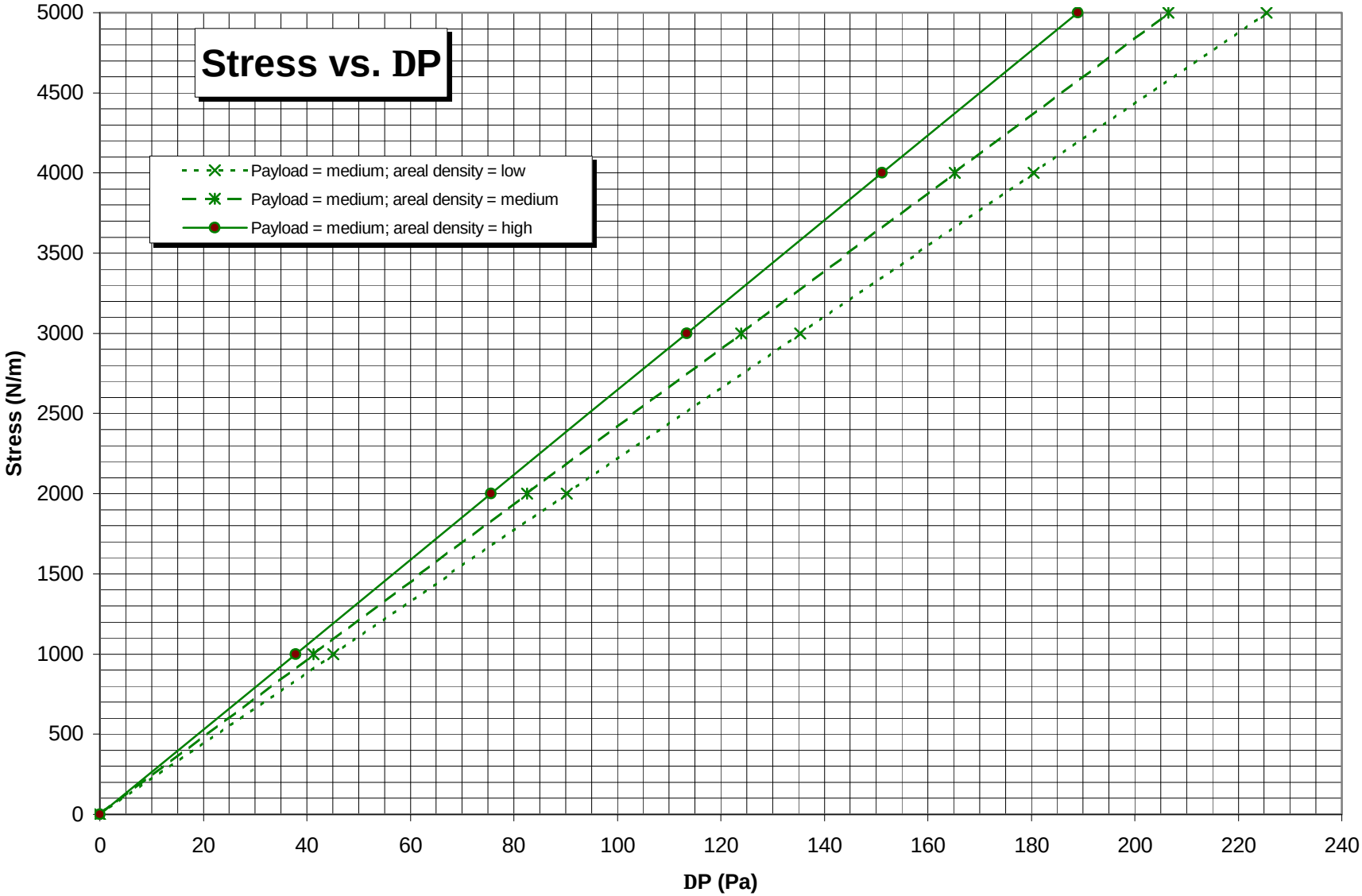
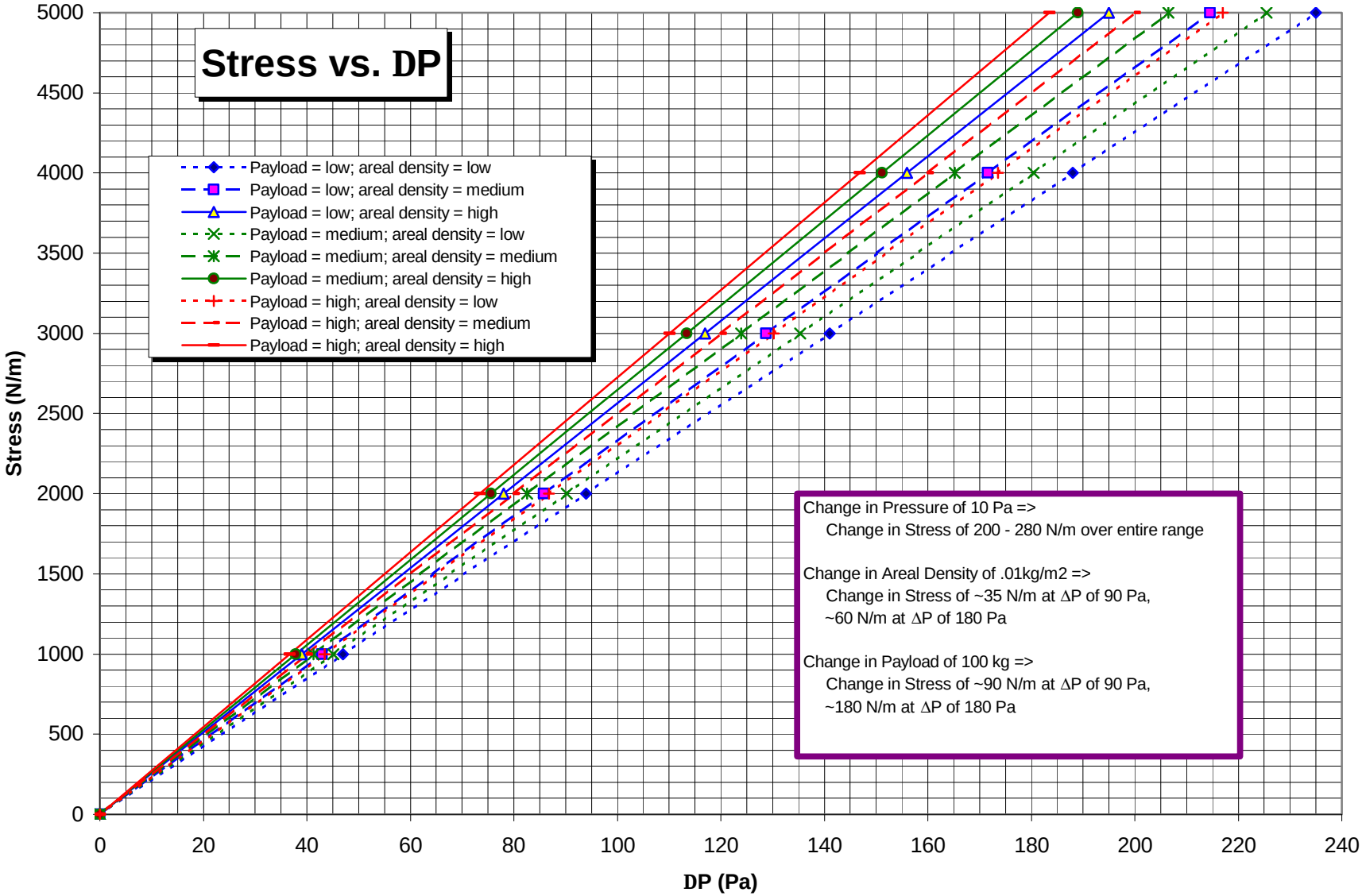

AREAL DENSITY VS. SYSTEM MASS
1364 kg Payload
1591 kg payload
1818 kg Payload
Change in Areal Density of .01 kg/m2 =>
Change in System Mass of ~400 - 500 kg
Change in Payload of 100 kg =>
Change in System Mass of 130 - 180 kg
SYSTEM MASS (KG)
AREAL DENSITY (KG/M2)
4900
4800
4700
4600
4500
4400
4300
4200
4100
4000
3900
3800
3700
3600
3500
3400
3300
3200
3100
3000
2900
2800
2700
2600
2500
2400
2300
2200
2100
2000
0.03
0.035
0.04
0.045
0.05
0.055
0.06
0.065
0.07

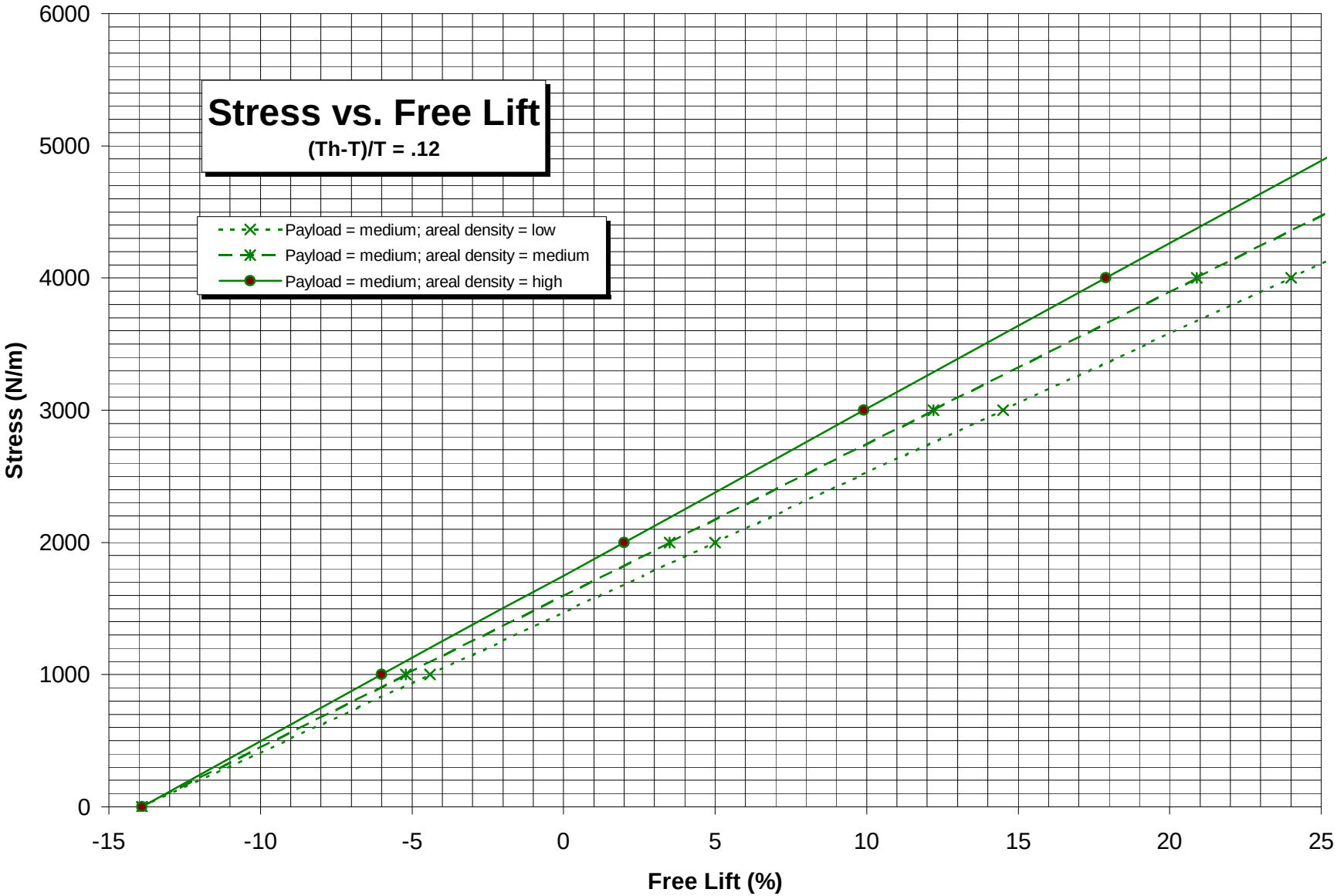

Temperature Change VS a/e
Spherical Balloon, Altitude 35 km
Temperature Change (°K)
TDayf ilm/gas-TNight film/gas
80
70
60
50
40
30
20
10
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
a/e
Hot Nominal Cold Minimum
Hot Nominal Cold Nominal
Hot Maximum Cold Minimum
Hot Maximum Cold Nominal
Temperature change is linear with respect to change in a/e ratio
Change of 0.05 in a/e changes temperature by 3 to 4 K

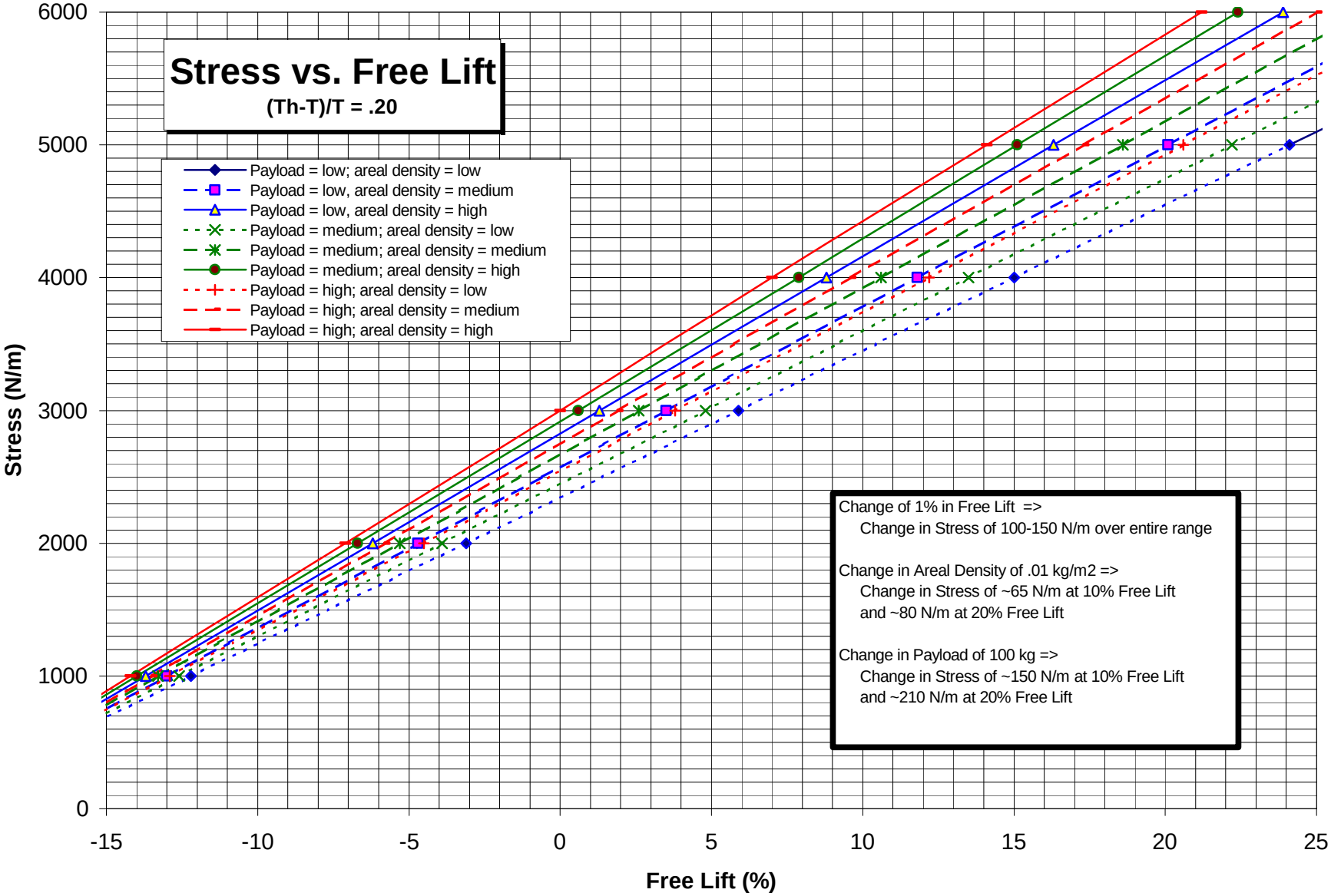

Strength a/e Material Density
Hot Case Max, Cold Case Min
Change in areal density by 17 gm/m^2 changes strength requirement by ~9.5%
Change in payload mass by 227 kg changes strength requirement by 3% to 4.5%
Change in a/e ratio by 0.05 changes strength requirement by 5.5% to 6.6%
Strength (N/m)
6500
6000
5500
5000
4500
4000
3500
3000
0.05
0.15
a/e
0.25
0.35
1364 kg, 34 gm/m^2
1591 kg, 34 gm/m^2
1818 kg, 34 gm/m^2
1364 kg, 51gm/m^2
1591 kg, 51 gm/m^2
1818 kg, 51gm/m^2
1364 kg, 68 gm/m^2
1591 kg, 68 gm/m^2
1818 kg, 68 gm/m^2

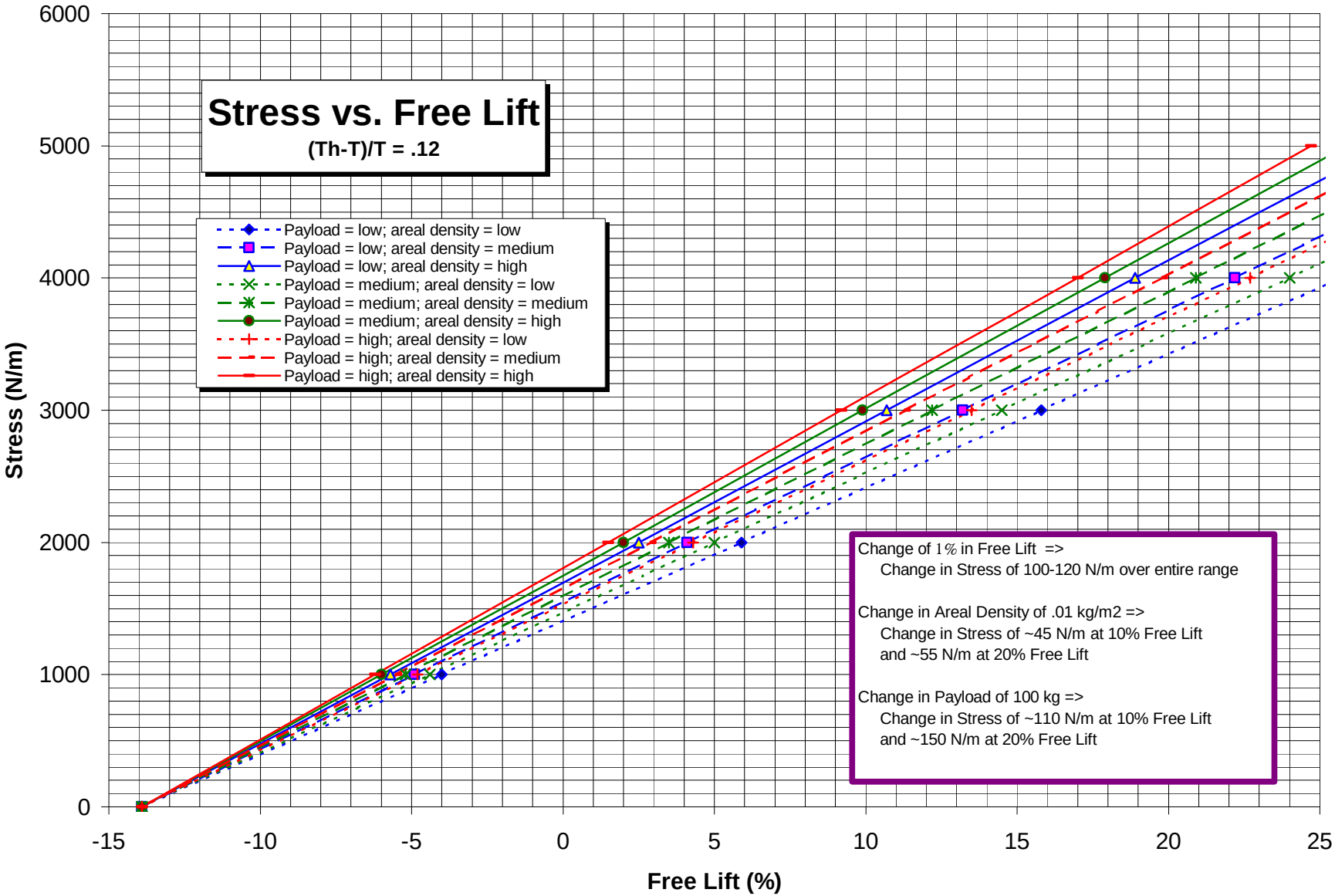

Strength a/e Material Density
Hot Case Nom, Cold Case Nom
Strength (N/m)
6500
6000
5500
5000
4500
4000
3500
3000
0.05
0.15
0.25
0.35
a/e
1364 kg, 34gm/m^2
1591 kg, 34 gm/m^2
1818 kg, 34 gm/m^2
1364 kg, 51gm/m^2
1591 kg, 51 gm/m^2
1818 kg, 51 gm/m^2
1364 kg, 68 gm/m^2
1591 kg, 68 gm/m^2
1818 kg, 68 gm/m^2
Change in areal density by 17 gm/m^2 changes strength requirement by ~9.5%
Change in payload mass by 227 kg changes strength requirement by 3% to 4.5%
Change in a/e ratio by 0.05 changes strength requirement by 5.5% to 6.6%

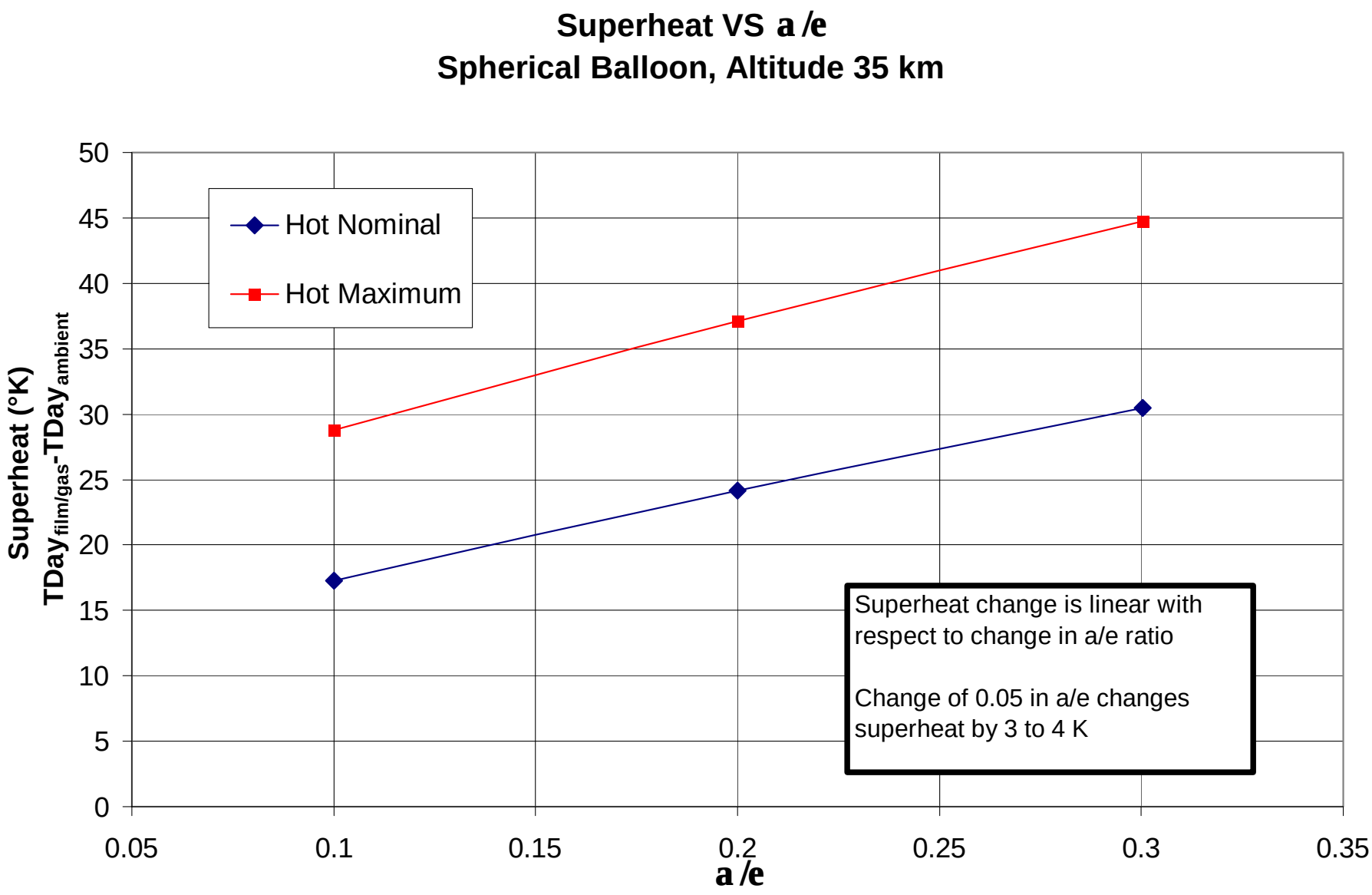

Stress vs. DP
Payload = medium; areal density = low
Payload = medium; areal density = medium
Payload = medium; areal density = high
Stress (N/m)
DP (Pa)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
20
40
60
80
100
120
140
160
180
200
220
240

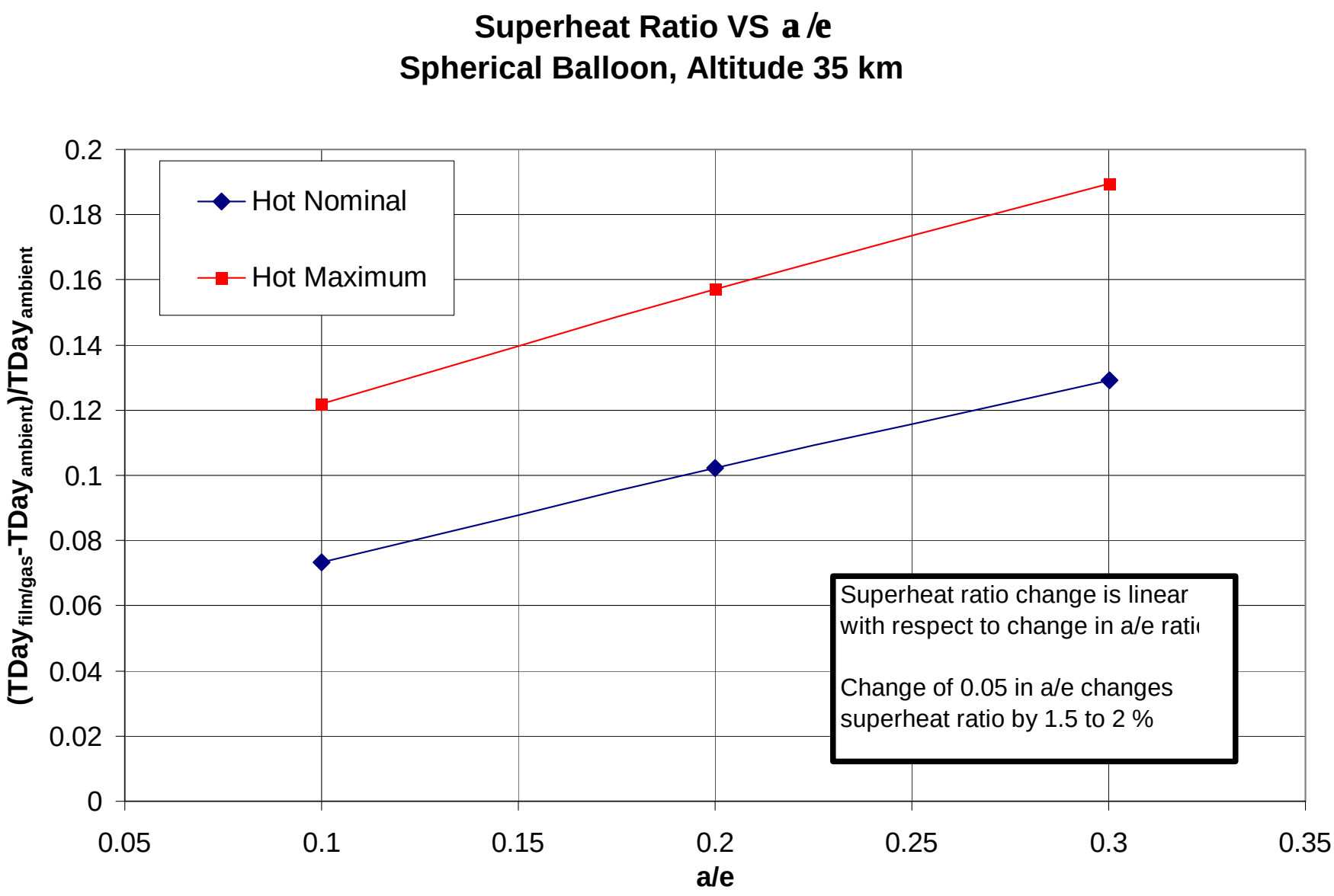

Stress vs. DP
Payload = low; areal density = low
Payload = low; areal density = medium
Payload = low; areal density = high
Payload = medium; areal density = low
Payload = medium; areal density = medium
Payload = medium; areal density = high
Payload = high; areal density = low
Payload = high; areal density = medium
Payload = high; areal density = high
Change in Pressure of 10 Pa =>
Change in Stress of 200 - 280 N/m over entire range
Change in Areal Density of .01kg/m2 =>
Change in Stress of ~35 N/m at ΔP of 90 Pa,
~60 N/m at ΔP of 180 Pa
Change in Payload of 100 kg =>
Change in Stress of ~90 N/m at ΔP of 90 Pa,
~180 N/m at ΔP of 180 Pa
Stress (N/m)
DP (Pa)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
0
20
40
60
80
100
120
140
160
180
200
220
240

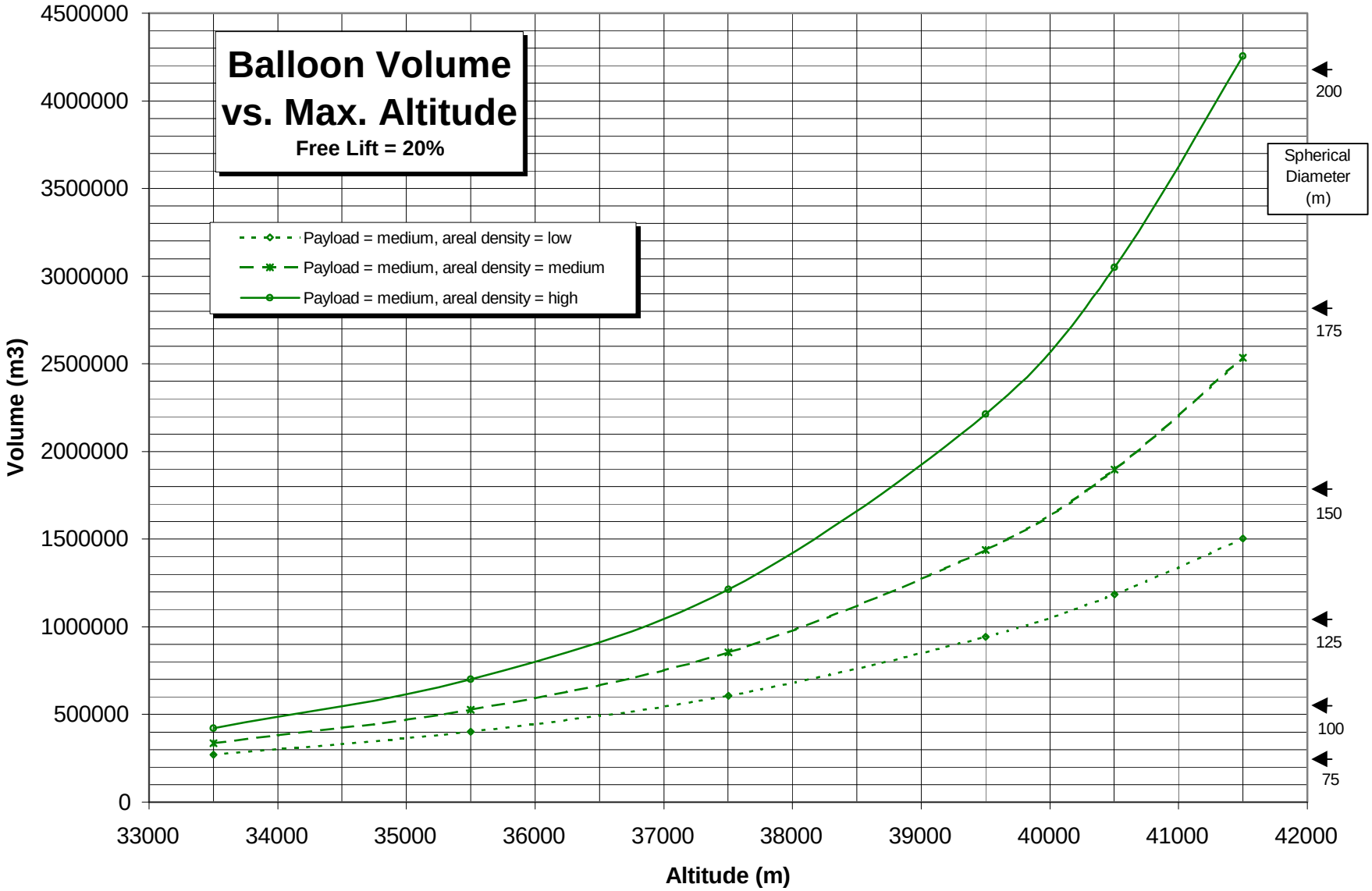

Stress vs. Free Lift
(Th-T)/T = .12
Payload = medium; areal density = low
Payload = medium; areal density = medium
Payload = medium; areal density = high
Stress (N/m)
Free Lift (%)
6000
5000
4000
3000
2000
1000
0
-15
-10
-5
0
5
10
15
20
25

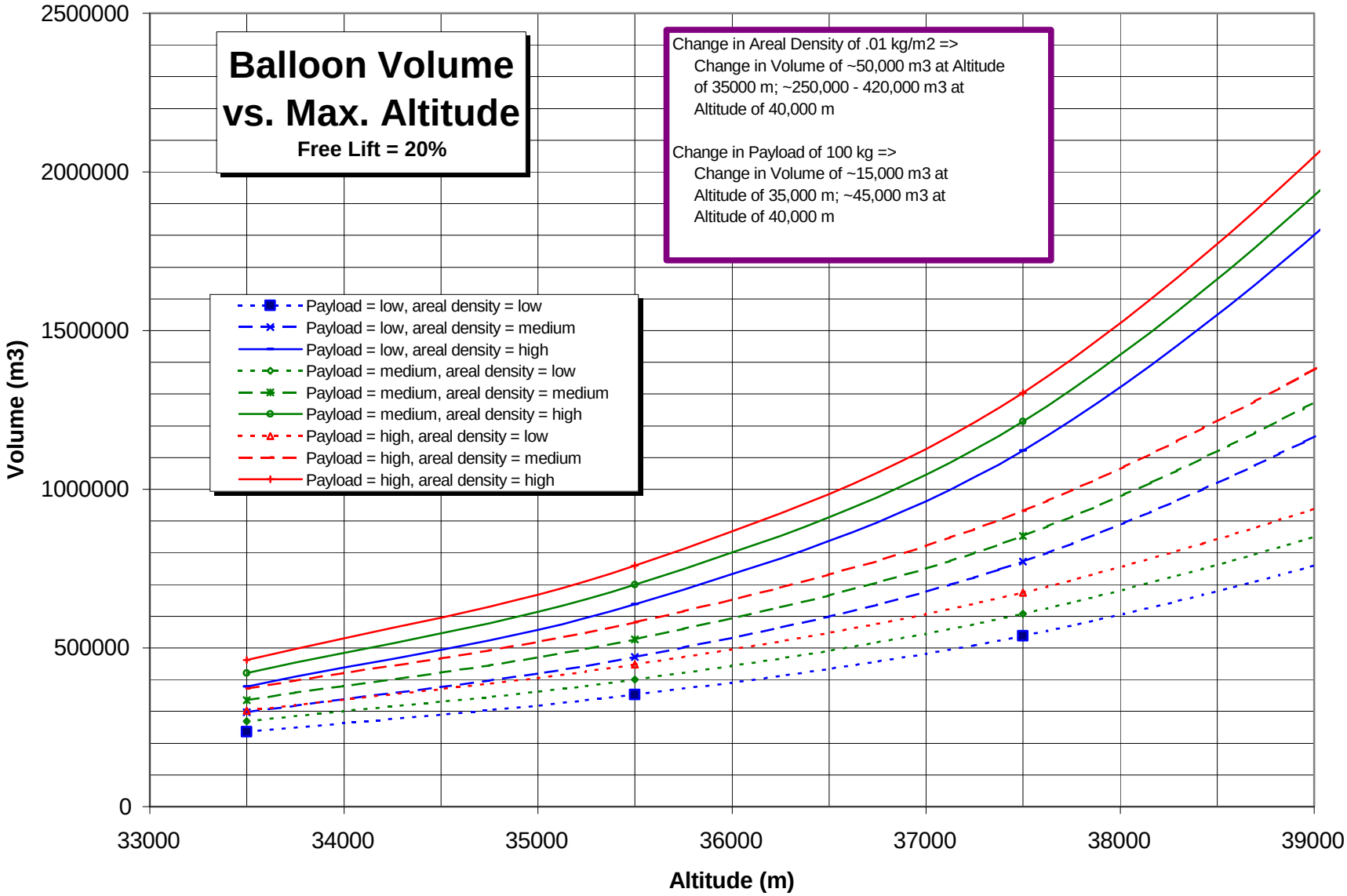

Stress vs. Free Lift
(Th-T)/T = .20
Payload = low; areal density = low
Payload = low, areal density = medium
Payload = low, areal density = high
Payload = medium; areal density = low
Payload = medium; areal density = medium
Payload = medium; areal density = high
Payload = high; areal density = low
Payload = high; areal density = medium
Payload = high; areal density = high
Change of 1% in Free Lift =>
Change in Stress of 100-150 N/m over entire range
Change in Areal Density of .01 kg/m2 =>
Change in Stress of ~65 N/m at 10% Free Lift
and ~80 N/m at 20% Free Lift
Change in Payload of 100 kg =>
Change in Stress of ~150 N/m at 10% Free Lift
and ~210 N/m at 20% Free Lift
Stress (N/m)
6000
5000
4000
3000
2000
1000
0
-15
-10
-5
0
5
10
15
20
25
Free Lift (%)

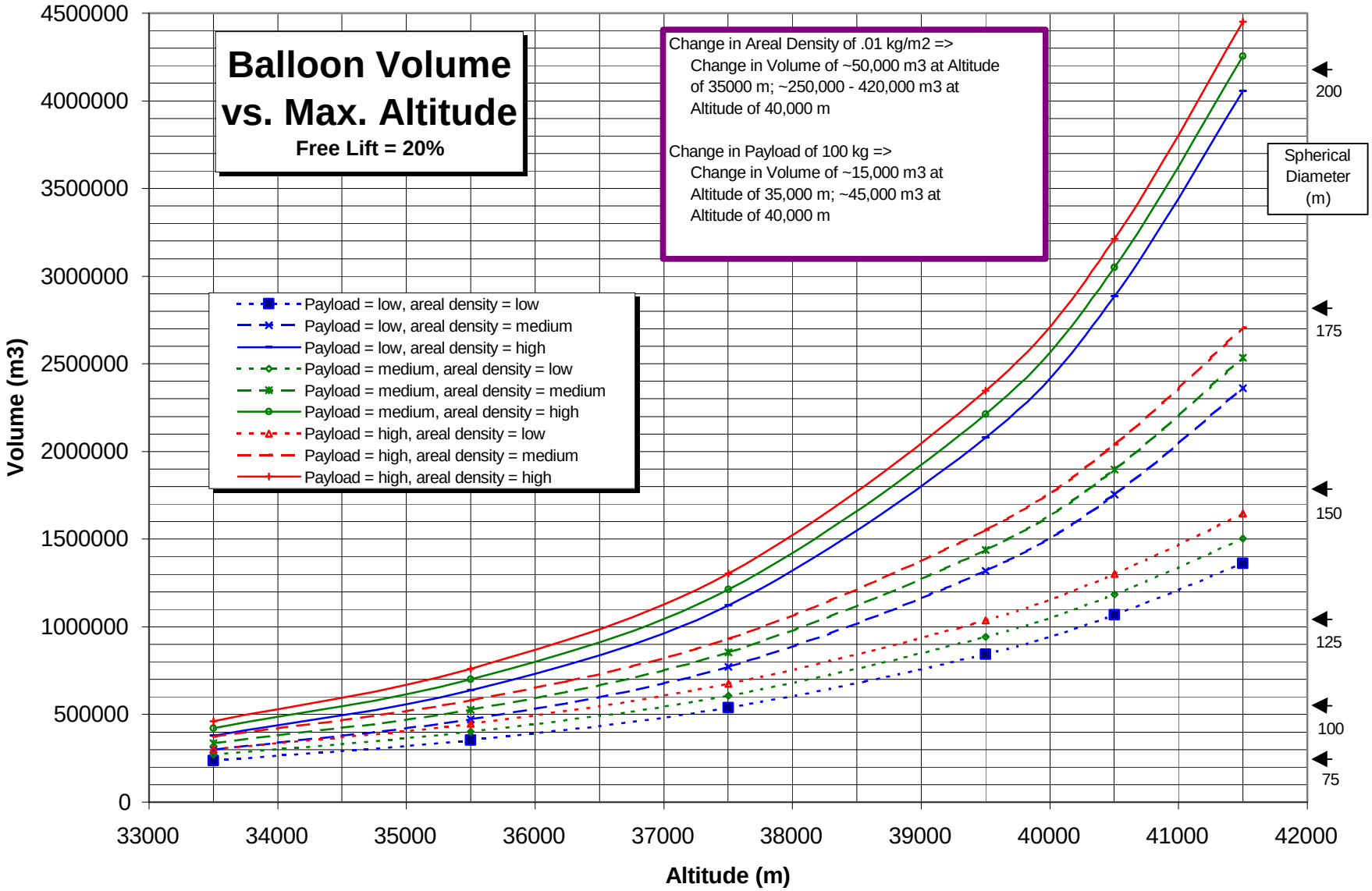

Stress vs. Free Lift
(Th-T)/T = .12
Payload = low; areal density = low
Payload = low; areal density = medium
Payload = low; areal density = high
Payload = medium; areal density = low
Payload = medium; areal density = medium
Payload = medium; areal density = high
Payload = high; areal density = low
Payload = high; areal density = medium
Payload = high; areal density = high
Change of 1% in Free Lift =>
Change in Stress of 100-120 N/m over entire range
Change in Areal Density of .01 kg/m2 =>
Change in Stress of ~45 N/m at 10% Free Lift
and ~55 N/m at 20% Free Lift
Change in Payload of 100 kg =>
Change in Stress of ~110 N/m at 10% Free Lift
and ~150 N/m at 20% Free Lift
Stress (N/m)
6000
5000
4000
3000
2000
1000
0
-15
-10
-5
0
5
10
15
20
25
Free Lift (%)

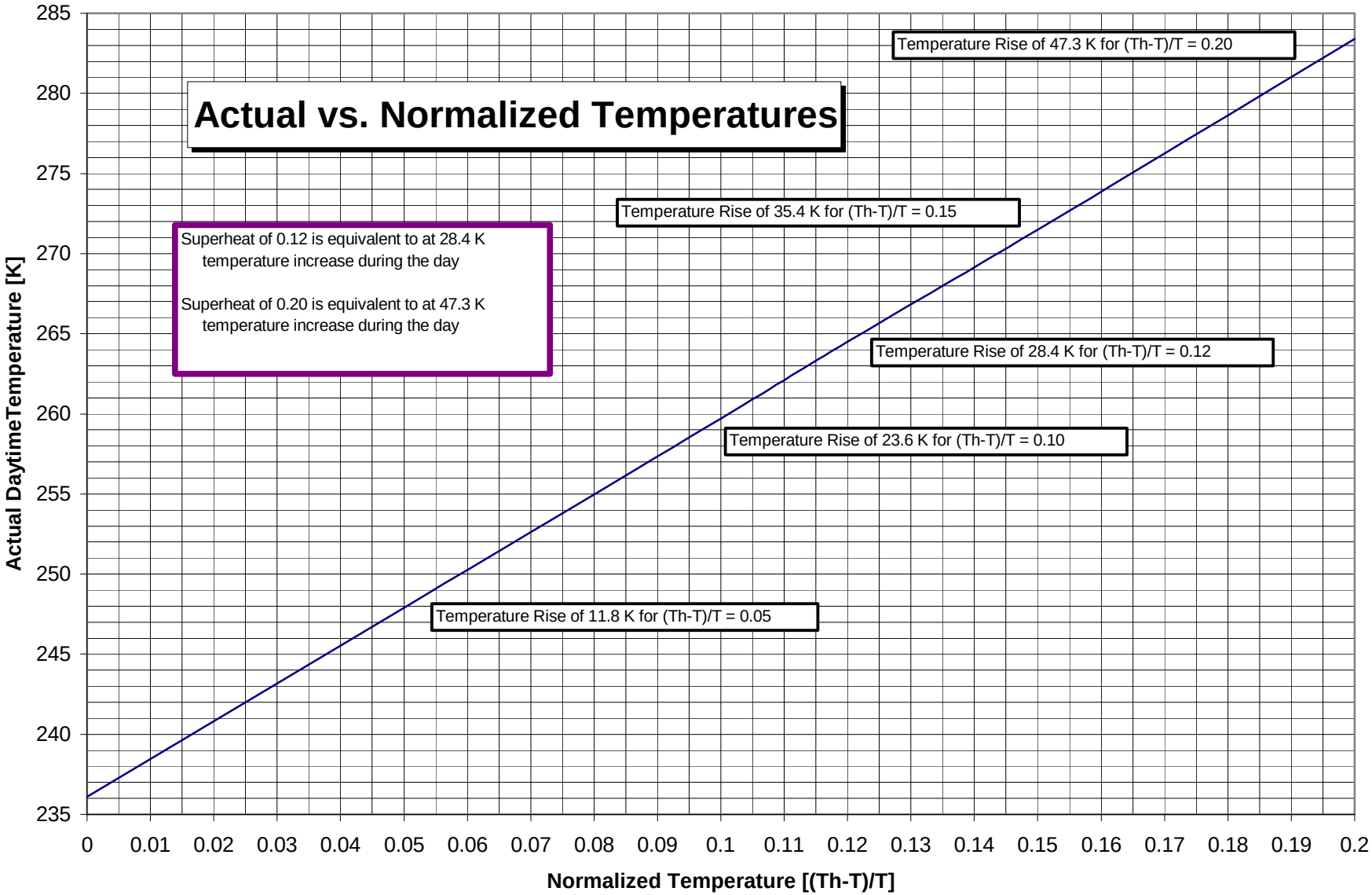

Superheat VS a /e
Spherical Balloon, Altitude 35 km
Hot Nominal
Hot Maximum
Superheat (°K)
TDay film/gas-TDay ambient
50
45
40
35
30
25
20
15
10
5
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
a /e
Superheat change is linear with respect to change in a/e ratio
Change of 0.05 in a/e changes superheat by 3 to 4 K


Superheat Ratio VS a /e
Spherical Balloon, Altitude 35 km
Hot Nominal
Hot Maximum
(TDay film/gas-TDay ambient)/TDay ambient
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
a/e
Superheat ratio change is linear
with respect to change in a/e rati
Change of 0.05 in a/e changes
superheat ratio by 1.5 to 2 %


Balloon Volume
vs. Max. Altitude
Free Lift = 20%
Payload = medium, areal density = low
Payload = medium, areal density = medium
Payload = medium, areal density = high
Spherical Diameter (m)
200
175
150
125
100
75
Volume (m3)
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
33000
34000
35000
36000
37000
38000
39000
40000
41000
42000
Altitude (m)


Balloon Volume vs. Max. Altitude
Free Lift = 20%
Change in Areal Density of .01 kg/m2 =>
Change in Volume of ~50,000 m3 at Altitude of 35000 m; ~250,000 - 420,000 m3 at Altitude of 40,000 m
Change in Payload of 100 kg =>
Change in Volume of ~15,000 m3 at Altitude of 35,000 m; ~45,000 m3 at Altitude of 40,000 m
Payload = low, areal density = low
Payload = low, areal density = medium
Payload = low, areal density = high
Payload = medium, areal density = low
Payload = medium, areal density = medium
Payload = medium, areal density = high
Payload = high, areal density = low
Payload = high, areal density = medium
Payload = high, areal density = high
Volume (m3)
2500000
2000000
1500000
1000000
500000
0
33000
34000
35000
36000
37000
38000
39000
Altitude (m)


Balloon Volume vs. Max. Altitude
Free Lift = 20%
Change in Areal Density of .01 kg/m2 =>
Change in Volume of ~50,000 m3 at Altitude of 35000 m; ~250,000 - 420,000 m3 at Altitude of 40,000 m
Change in Payload of 100 kg =>
Change in Volume of ~15,000 m3 at Altitude of 35,000 m; ~45,000 m3 at Altitude of 40,000 m
Payload = low, areal density = low
Payload = low, areal density = medium
Payload = low, areal density = high
Payload = medium, areal density = low
Payload = medium, areal density = medium
Payload = medium, areal density = high
Payload = high, areal density = low
Payload = high, areal density = medium
Payload = high, areal density = high
Spherical Diameter (m)
200
175
150
125
100
75
Volume (m3)
4500000
4000000
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
33000
34000
35000
36000
37000
38000
39000
40000
41000
42000
Altitude (m)


Actual vs. Normalized Temperatures
Temperature Rise of 47.3 K for (Th-T)/T = 0.20
Temperature Rise of 35.4 K for (Th-T)/T = 0.15
Temperature Rise of 28.4 K for (Th-T)/T = 0.12
Temperature Rise of 23.6 K for (Th-T)/T = 0.10
Temperature Rise of 11.8 K for (Th-T)/T = 0.05
Superheat of 0.12 is equivalent to at 28.4 K temperature increase during the day
Superheat of 0.20 is equivalent to at 47.3 K temperature increase during the day
Actual DaytimeTemperature [K]
285
280
275
270
265
260
255
250
245
240
235
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09
0.1
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.2
Normalized Temperature [(Th-T)/T]