LDP Example – Las Cruces, New Mexico

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Two points from NGS Data Base are about 16 km apart and have elevation difference of 160 m:

A. CrucesAir NAD 83(2011)

ϕ = 32° 16' 54."63269 N
λ = 106° 55' 22."24763 W
Ellipsoid Height = 1,326.205 m
Geoid Height = -24.08 m
Ortho Height = 1,350.3 m
X = -1,571,430.649 m
Y = -5,164,782.254 m
Z = 3,387,603.202 m

State Plane, North Zone – meters
Northing = 142,315.959 m
Easting = 436,621.577 m
Grid scale factor = 0.99994952
Combined factor = 0.99974134

B. Reilly NAD 83(2011)

ϕ = 32° 16' 55.93001 N
λ = 106° 45' 15.16035 W
Ellipsoid Height = 1,166.543 m
Geoid Height = -23.94 m
Ortho Height = 1,190.5 m
X = -1,556,177.595 m
Y = -5,169,235.284 m
Z = 3,387,551.720 m

Northing = 142,268.771 m
Easting = 452,506.490 m
Grid scale factor = 0.99992781
Combined factor = 0.99974469

Same two points computed on LDP:

B. CrucesAir (LDP)

ϕ = 32° 16' 54."63269 N
λ = 106° 55' 22."24763 W
Northing = 3,544.8009 m
Easting = 33,714.4327 m
Modified GSF = 0.99999327

B. Reilly (LDP)

ϕ = 32° 16' 55.93001 N
λ = 106° 45' 15.16035 W
Northing = 3,571.6578 m
Easting = 49,603.2227 m
Modified GSF = 0.99999000

From Reilly to CrucesAir (average elevation)

State plane grid distance $D_{SPC} = \sqrt{\Delta e^2 + \Delta n^2} =$	15,884.983 m
Average combined factor = (0.99974134+0.99974469)/2 =	0.99974302
Average ground distance, D_{HD} = D_{SPC} / ave. CF	15,889.066 m
LDP grid distance $D_{LDP} = \sqrt{\Delta e^2 + \Delta n^2} =$	15,888.813 m
Average modified grid scale factor (ave. MGSF) =	0.99999164
Average line height from 1,200 m: h = 1,246.37 – 1,200.0 =	46.37 m
(Use average earth radius = 6,372,200 m); R/(R+h) =	0.99999272
Average modified combined factor = ave. MGSF*R/(R+h) =	0.99998436
Average height ground distance, D_{HD} = LDP grid dist / ave. CF =	15,889.061 m

Note – with proper corrections applied, ground distances agree within 0.005 m or 1:3,000,000. If in this case, the elevation factor is ignored for the LDP values, then the ground distance agrees within 0.253 m over a distance of 15,889 meters or 1:62,800. The question is, "how precise must the computations be performed or how good is good enough?" That depends upon user/application.

A formal reference for accuracy of elevation factor is http://www.globalcogo.com/ElevFact.pdf