

```

title1 " ";
options nodate nonumber ls=80 nocenter;
data aircraft;
input Observation y      x1      x2      x3;
cards;
1      0      0      4      91.5
2      1      0      4      84.0
3      0      0      4      76.5
4      0      0      5      69.0
5      0      0      5      61.5
6      0      0      5      80.0
7      1      0      6      72.5
8      0      0      6      65.0
9      0      0      6      57.5
10     2      0      7      50.0
11     1      0      7      103.0
12     1      0      7      95.5
13     1      0      8      88.0
14     1      0      8      80.5
15     2      0      8      73.0
16     3      1      7      116.1
17     1      1      7      100.6
18     1      1      7      85.0
19     1      1      10     69.4
20     2      1      10     53.9
21     0      1      10     112.3
22     1      1      12     96.7
23     1      1      12     81.1
24     2      1      12     65.6
25     5      1      8      50.0
26     1      1      8      120.0
27     1      1      8      104.4
28     5      1      14     88.9
29     5      1      14     73.7
30     7      1      14     57.8
;

```

```

proc genmod;
model y = x1 x2 x3 / dist=poisson link = log type3;
run;

```

The GENMOD Procedure

Model Information

Data Set	WORK.AIRCRAFT
Distribution	Poisson
Link Function	Log
Dependent Variable	y

Number of Observations Read	30
Number of Observations Used	30

The Aircraft Damage Data

During the Vietnam War, the United States Navy operated several types of attack (a bomber in USN parlance) aircraft, often for low-altitude strike missions against bridges, roads, and other transportation facilities. Two of these included the McDonnell Douglas A-4 Skyhawk and the Grumman A-6 Intruder. The A-4 is a single-engine, single-place light attack aircraft used mainly in daylight. It was also flown by the Blue Angels, the Navy's flight demonstration team, for many years. The A-6 is a twin-engine, dual-place, all-weather medium attack aircraft with excellent day/night capabilities. However, the Intruder could not be operated from the smaller Essex-class aircraft carriers, many of which were still in service during the conflict.

Considerable resources were deployed against the A-4 and A-6, including small arms, AAA or antiaircraft artillery, and surface-to-air missiles. Table 13.4 contains data from 30 strike missions involving these two types of aircraft. The regressor x_1 is an indicator variable (A-4 = 0 and A-6 = 1), and the other regressors x_2 and x_3 are bomb load (in tons) and total months of aircrew experience. The response variable is the number of locations where damage was inflicted on the aircraft.

We will model the damage response as a function of the three regressors. Since the response is a count, we will use a Poisson regression model with the log link.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	26	25.9532	0.9982
Scaled Deviance	26	25.9532	0.9982
Pearson Chi-Square	26	23.9384	0.9207
Scaled Pearson X2	26	23.9384	0.9207
Log Likelihood		-12.3726	

Algorithm converged.

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits	Chi-Square	Pr > ChiSq
Intercept	1	-0.4060	0.8775	-2.1259 1.3138	0.21	0.6436
x1	1	0.5688	0.5044	-0.4198 1.5573	1.27	0.2595
x2	1	0.1654	0.0675	0.0330 0.2978	6.00	0.0143
x3	1	-0.0135	0.0083	-0.0298 0.0027	2.67	0.1025
Scale	0	1.0000	0.0000	1.0000 1.0000		

NOTE: The scale parameter was held fixed.

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
x1	1	1.27	0.2604
x2	1	6.24	0.0125
x3	1	2.68	0.1015


```

title1 " ";
options nodate nonumber ls=80 nocenter;
data yarn;
input x1    x2    x3    cycles;
cards;
-1    -1    -1    674
0     -1    -1    1414
1     -1    -1    3636
-1    0     -1    338
0     0     -1    1022
1     0     -1    1568
-1    1     -1    170
0     1     -1    442
1     1     -1    1140
-1    -1    0     370
0     -1    0     1198
1     -1    0     3184
-1    0     0     266
0     0     0     620
1     0     0     1070
-1    1     0     118
0     1     0     332
1     1     0     884
-1    -1    1     292
0     -1    1     634
1     -1    1     2000
-1    0     1     210
0     0     1     438
1     0     1     566
-1    1     1     90
0     1     1     220
1     1     1     360
;

```

The Worst Yarn Experiment

contains data from an experiment conducted to investigate the three factors x_1 = length, x_2 = amplitude, and x_3 = load on the cycles to failure y of worst yarn. The regressor variables are coded, and readers who have familiarity with designed experiments will recognize that the experimenters here used a 3^3 factorial design.

The response variable in this experiment is an example of a nonnegative response that would be expected to have an asymmetric distribution with a long right tail. Failure data are frequently modeled with exponential, Weibull, lognormal, or gamma distributions both because they possess the anticipated shape and because sometimes there is theoretical or empirical justification for a particular distribution.

We will model the cycles to failure data with a GLM using the gamma distribution and the log link.

```

proc genmod;
model cycles = x1 x2 x3 / dist=gamma link = log type3;
run;

```

The GENMOD Procedure

Model Information

Data Set	WORK.YARN
Distribution	Gamma
Link Function	Log
Dependent Variable	cycles

Number of Observations Read	27
Number of Observations Used	27

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	23	0.7694	0.0335
Scaled Deviance	23	27.1276	1.1795
Pearson Chi-Square	23	0.7274	0.0316
Scaled Pearson X2	23	25.6456	1.1150
Log Likelihood		-161.3784	

Algorithm converged.

Analysis Of Parameter Estimates

Parameter	DF	Estimate	Standard Error	Wald 95% Confidence Limits		Chi-Square	Pr > ChiSq
Intercept	1	6.3489	0.0324	6.2854	6.4124	38373.0	<.0001
x1	1	0.8425	0.0402	0.7636	0.9214	438.36	<.0001
x2	1	-0.6313	0.0396	-0.7090	-0.5536	253.76	<.0001
x3	1	-0.3851	0.0402	-0.4639	-0.3064	91.86	<.0001
Scale	1	35.2585	9.5511	20.7340	59.9576		

NOTE: The scale parameter was estimated by maximum likelihood.

LR Statistics For Type 3 Analysis

Source	DF	Chi-Square	Pr > ChiSq
x1	1	77.29	<.0001
x2	1	63.43	<.0001
x3	1	40.11	<.0001