Fake P Phases

In early 1998, the ISC learned that "fake P" readings from the US National Seismic Network had been finding their way into the published ISC Bulletin. In response to an enquiry from the ISC, NEIC's Bruce Presgrave described the purpose and properties of these spurious phase readings. Body wave arrivals are required to anchor surface wave amplitudes in the NEIC data management system. Because of high-frequency noise at some USNSN stations, however, it is sometimes possible to measure a surface wave amplitude where no body wave is detectable. To avoid excluding useful amplitudes from the data, P arrivals are inserted into the database with properties that are intended to prevent their use by any careful seismologist, including a large positive travel time residual.

The ISC accepts phase readings from NEIC, and the fake P's were included. The outcome has almost always been harmless: the association and identification are unchanged, the residual remains large, and the arrival time is automatically assigned an effectively null weight in computing the event location. Occasionally, however, the phase is reassociated or re-identified by an ISC Bulletin editor as pP or sP, potentially leading to an inaccurate event depth.

An algorithm has been developed to identify the fake P's in NEIC data files with very high confidence. In arrivals from the first month of 1996, the algorithm identified 621 fake P's and a comprehensive manual review of the flagged arrivals showed one apparent mis-identification. From the start of 1996, fake P's will routinely have an operator identification code 111 and a null ISC identification in ISC products, and be neglected in processing.

Fake P's are likely to be have been included in the ISC Bulletin at least back to 1992, and we will be evaluating means for properly identifying these arrivals in the processed data. Further details are given below.

Fake P times are created at NEIC in order to enable measurements of surface wave amplitude and period to be used in the determination of event surface wave magnitudes. There are occasions when a surface wave amplitudes and periods can be measured but the first onset is non determinable. This often applies at oceanic stations such as HON. NEIC phase association rules will not associate the data unless a primary phase time is reported.

At the ISC, fake P's are identified when all of these conditions hold:

1. The data comes from NEIC
2. The time is exactly on a ten second boundary
3. The NEIC priority code is '10*' or '20*' (The priority code discriminant reported by Presgrave was somewhat more restricted than this, but the ISC does not appear to retain the third character of the priority code.)
4. There are exactly two 'phases' reported. The first being the onset time and the second the surface wave amplitude and period
5. The phase identification is P.
6. No amplitude, log a/t, period etc. for the first phase
7. No onset time, phase id, etc. for second phase
8. Amplitude and period are from vertical component

These rules were established based on discussions with Bruce Presgrave that following notification that NEIC had routinely included fake P times in the data stream reported to the ISC. A study of the NEIC phase readings data stream as supplied to ISC was undertaken.

Using the data for 1996 January as a sample, the following facts emerged.

The total number of RAGs (Reading Associated Group) for 199601 was 98524.

Primary times are given to 1/100th of a second.

	found	random
Times falling exactly on an hour boundary	2	0
Times falling exactly on a ten minute boundary	54	2
Times falling exactly on a one minute boundary	465	16
Times falling exactly on a ten second boundary	2678	98
Times falling exactly on a one second boundary	18537	985
Times falling exactly on one tenth second boundary	72621	9852
Times with 1/100th non zero	25903	88672

There are 1153 RAGs with times exactly on a ten second mark which also report surface wave data. From these there are 620 RAGs which report the phase id as 'P', leave the emergent/impulsive indicator and identification quality fields as blank and only report the vertical component in the surface wave field. All these records report Priority path code as 106 or 206. Where

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character 1 = 1    quick and dirty
              2    preliminary
character 2 = 0    local (interpretation generated at NEIS)
                   or phoned to NEIS
character 3 = 6    treat amplitudes as ground amplitudes
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The following table shows the stations found and their frequency of occurrence

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11 ALQ  Albuquerque    New Mexico           W   34:56:33  N 106:27:27  W 1849
 4 ARU  Arti           Sverdlovskaya        B   56:25:48.7N  58:33:45.0E  250
 1 BDFB Brasilia       Distrito Federal         15:38:28.3S  48:00:50.9W 1095
 1 BGCA Bogoin         Central African Republic/ 5:10:34  N  18:25:27  E  576
16 BINY Binghamton     New York                 42:11:57.5N  75:59:10.0W  498
19 BMN  Battle Mountain/Nevada                  40:25:53.3N 117:13:18.4W 1594
 3 BOSA Boshof         South Africa             28:36:50.7S  25:15:19  E 1202
15 CBKS Cedar Bluff    Kansas                   38:48:50.4N  99:44:14.6W  667
11 CCM  Cathedral Cave Missouri                 38:03:20.4N  91:14:40.5W  223
19 CEH  Chapel Hill    North Carolina           35:53:27  N  79:05:34  W  152
19 CMB  Columbia College/California             38:02:06  N 120:23:06  W  719
12 COR  Corvallis      Oregon               BW  44:35:08.6N 123:18:11.5W  121
15 DUG  Dugway         Utah                 BW  40:11:42  N 112:48:48  W 1477
 4 ELK  Elko           Nevada                   40:44:41.4N 115:14:19.6W 2210
 2 EYMN Ely            Minnesota                47:56:46.3N  91:29:42.0W  475
 9 FVM  French Village Missouri                 37:59:02.4N  90:25:33.6W  310
14 GLD  Golden         Colorado                 39:45:02  N 105:13:17  W 1762
 1 GOGA Godfrey        Georgia                  33:24:40.3N  83:27:59.8W  150
18 GOL  Golden         Colorado             BCW 39:42:01  N 105:22:16  W 2359
10 HKT  Hockley        Texas                    29:57     N  95:50     W -415
36 HON  Honolulu       Hawaii               W   21:19:27  N 158:00:02  W    2
20 HRV  Harvard        Massachusetts            42:30:23  N  71:33:30  W  180
20 ISA  Isabella       California           B   35:39:48  N 118:28:24  W  835
 7 JFWS Jewell Farm    Wisconsin                42:54:51.3N  90:14:53.1W  335
18 LBNH Lisbon         New Hampshire            44:14:24.4N  71:55:33.2W  367
 1 LBTB Lobatse        Botswana                 25:00:52.2S  25:35:49.2E 1028
 1 LKWY Lake           Wyoming                  44:33:54.7N 110:24:00.0W 2424
19 LSCT Lakeside       Connecticut              41:40:42.2N  73:13:27.8W  318
 9 LTX  Lajitas        Texas                    29:20:02  N 103:40:01  W 1013
19 MCWV Mont Chateau   West Virginia            39:39:29.2N  79:50:44.2W  280
19 MIAR Mount Ida      Arkansas                 34:32:44.5N  93:34:22.8W  207
21 MNV  Mina           Nevada               B   38:25:55.9N 118:09:15.8W 1507
17 MYNC Murphy         North Carolina           35:04:26.0N  84:07:40.4W  550
19 NEW  Newport        Washington               48:15:48  N 117:07:12  W  760
12 OBN  Obninsk        Kaluzhskaya          B   55:10     N  36:36     E
12 PFO  Pinyon Flat Obs./California             33:36:33  N 116:27:19  W 1280
19 SAO  SanAndreas Obs./California          B   36:45:54  N 121:26:42  W  350
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  1 SBA  Scott Base     Victoria Land        BW  77:51:01  S 166:45:22  E   38
  1 SDN  Sand Point     Alaska and Aleutians     55:20:28.8N 160:29:49.8W   23
  4 SIT  Sitka          Alaska and Aleutians     57:03:25  N 135:19:28  W   19
 12 SLM  Saint Louis    Missouri             B   38:38:10  N  90:14:10  W  161
 15 SMTC Superstition Mt./California             32:56:56.4N 115:43:12.0W  -50
  1 SMY  Shemya         Alaska and Aleutians     52:43:51  N 174:06:11  E   58
 18 SSPA Standing Stone Pennsylvania            40:38:08.9N  77:53:16.8W  158
 20 TPNV Topopah Spring Nevada                  36:56:55.8N 116:14:58.2W 1600
 16 TUC  Tucson         Arizona              BW  32:18:35  N 110:47:03  W  906
  1 VNDA Vanda          Victoria Land            77:30:50.2S 161:50:44.2E   98
 13 WDC  Whiskeytown    California               40:34:48  N 122:32:23  W  300
 18 WMOK Wichita Mts    Oklahoma                 34:44:16.4N  98:46:51.6W  486
  8 WVOR Wild Horse Valley/Oregon               42:26:02.2N 118:38:12.2W 1344
 19 YSNY Yorkshire      New York                 42:28:32.9N  78:32:15.0W  628
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A program to count the frequency of records of different types produced:

count	**record class**
98524	all records
3418	records with surface wave values
2057	records with only vertical component surface wave data
2678	records with time exactly on ten second boundary
80998	records with primary phase code given as P
20378	records with onset code blank
954	records with path code 106 or 206
1090	records with only first arrival and surface wave
903	only first arrival and Z component surface wave
621	satisfy all above criteria
1	satisfy all criteria except time is not on 10 sec. marker
0	satisfy all criteria except path not 106 or 206
0	satisfy all criteria except onset not blank
0	satisfy all criteria except ident not P
0	satisfy all criteria except no surface wave
0	satisfy all criteria except no Z surface wave
0	satisfy all criteria except not primary and sw only

The records from the NEIS station list seem to show that all the stations belong to appropriate networks to be treated in this fashion.