

# Reducing Accelerator Downtime: Log Monitoring and Active Management



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**Objective**

To develop an accelerator monitoring and maintenance program that helps minimize downtime during normal clinic treatment hours for a regional radiotherapy network.

**Materials and Methods**

Program elements include: vendor maintenance contracts and specific engineer-site assignments; accelerator fault and warning tracking by therapist site team; weekly event log and fault-warning log review by site physicist; and monthly technical review by physics leadership. Service contracts for each accelerator includes extended service coverage to 9 pm. Site specific software tools were developed to log and monitor each operational aspect and allows active management of each accelerator. Current monitoring includes eight accelerators at seven sites. The vendor service team attends facility team meetings to discuss clinical use and operational events. The radiation oncology staff is incentivized to log all operational warnings and faults. Compliance is scored on a five-point scale with staff annual reviews and compensation impacted by the compliance score. Monthly review ensures actionable operational issues are resolved proactively. Ongoing analysis of accelerator downtime is documented using field service statistics and facility tracking.

**Results**

Compliance scores for each clinic range from 95 to 100 percent over the first 8 months of program operation. Overall compliance is 97.3 percent. Overall machine downtime for calendar year 2015 was 4.7 percent. In 2016 only one clinic had an increase in downtime due to a major system failure and facility electrical power issues in January 2016. Machine downtime for calendar year 2016 was 2.6 percent, a significant decrease. Alternatively, downtime was decreased from 676 hours in 2015 to 368.9 hours in 2016. In addition, by gaining 307.1 hours of accelerator operating time, the increase in net profit is approximately 338 thousand dollars to the practice.

**Conclusions**

A systematic, focused program for decreasing accelerator downtime that includes all radiation oncology stakeholders can increase operational availability of accelerator systems.

Table 1. The warning and error log compliance is part of each RTT and physicists' annual review and is a factor in determining eligibility for merit increases. Compliance scores for each clinic ranges from 95% to 100% over the first 8 months of program operation [table 1]. Overall compliance is 97.3% across all centers.

| Monthly Facility/Physicist Review  | Tasks Reviewed                 | Site 1: 21 EX         | Site 2: Trilogy | Site 3: 21 EX | Site 4: 21 EX | Site 5: Trilogy | Site: 6: Trilogy | Site 7: TB                           |        |
|------------------------------------|--------------------------------|-----------------------|-----------------|---------------|---------------|-----------------|------------------|--------------------------------------|--------|
| Preemptive Accelerator Maintenance |                                |                       |                 |               |               |                 |                  |                                      |        |
| May                                | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 5               | 5             | 3             | 5               | 5                | N/A                                  |        |
| June                               | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 5               | 5             | 5             | 5               | 5                | N/A                                  |        |
| July                               | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 4               | 5             | 5             | 5               | 5                | N/A                                  |        |
| August                             | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 5               | 5             | 5             | 5               | 5                | N/A                                  |        |
| September                          | Machine Error Log Complete     | 3                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 4               | 5             | 3             | 5               | 5                | N/A                                  |        |
| October                            | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 5                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 5               | 5             | 5             | 5               | 5                | N/A                                  |        |
| November                           | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 4                                    |        |
|                                    | Accelerator Log Files Reviewed | 5                     | 5               | 5             | 5             | 5               | 5                | N/A                                  |        |
| December                           | Machine Error Log Complete     | 5                     | 5               | 5             | 5             | 5               | 5                | 4                                    |        |
|                                    | Accelerator Log Files Reviewed | 4                     | 4               | 4             | 5             | 5               | 4                | N/A                                  |        |
|                                    | Comments                       |                       |                 |               |               |                 |                  | Log files reviewed by Varian Medical |        |
| Score: 5-complete; 0-Not done      |                                | Total Score           | 77              | 77            | 79            | 76              | 80               | 79                                   | 38     |
|                                    |                                | Completion Percentage | 96.25%          | 96.25%        | 98.75%        | 95.00%          | 100.00%          | 98.75%                               | 95.00% |

| Site            | Year | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec     | Total Downtime (Hours) | Average |
|-----------------|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|------------------------|---------|
| Site 1: 21 EX   | 2015 | 1      | 2      | 5      | 3      | 4      | 10     | 4      | 0      | 3      | 43     | 21     | 21      | 117.0                  | 9.8     |
|                 | 2016 | 2      | 11     | 2      | 4.4    | 0.5    | 0      | 6      | 2.25   | 1      | 7      | 2      | 0       | 38.2                   | 3.2     |
| Site 2: Trilogy | 2015 | 5      | 5      | 6      | 0      | 0      | 2      | 5      | 5      | 6      | 5      | 3      | 5       | 47.0                   | 3.9     |
|                 | 2016 | 1      | 2      | 3      | 4      | 4.75   | 0      | 9      | 8      | 0      | 1      | 0      | 0       | 32.8                   | 2.7     |
| Site 3: 21 EX   | 2015 | 5      | 2      | 7      | 9      | 120    | 7      | 1      | 19     | 7      | 5      | 5      | 25      | 92.0                   | 8.4     |
|                 | 2016 | 6      | 23     | 2      | 6.5    | 0      | 1      | 2      | 5      | 2      | 6      | 0      | 0       | 53.5                   | 4.5     |
| Site 4: 21 EX   | 2015 | 8      | 2      | 1      | 1      | 0      | 1      | 4      | 2      | 23     | 11     | 8      | 1       | 62.0                   | 5.2     |
|                 | 2016 | 14     | 0      | 2.5    | 3.2    | 0      | 1      | 0      | 11     | 8      | 1      | 12     | 0       | 52.7                   | 4.4     |
| Site 5: Trilogy | 2015 | 5      | 7      | 10     | 1      | 38     | 2      | 0      | 5      | 3      | 5      | 1      | 3       | 80.0                   | 6.7     |
|                 | 2016 | 2      | 4      | 1.25   | 1      | 0      | 0      | 1      | 1.5    | 1      | 10     | 5      | 0       | 26.8                   | 2.2     |
| Site 6: Trilogy | 2015 | 0      | 0      | 0      | 9      | 8      | 18     | 9      | 0      | 8      | 5      | 1      | 0       | 58.0                   | 4.8     |
|                 | 2016 | 0      | 11     | 15     | 1      | 0      | 0      | 0      | 1.5    | 0      | 0.5    | 0      | 0       | 29.0                   | 2.4     |
| Site 7: TB      | 2015 | 6      | 16     | 9.5    | 9      | 3      | 0      | 1      | 4      | 10     | 15.5   | 6      | 20      | 100.0                  | 8.3     |
|                 | 2016 | 89     | 4      | 2      | 14     | 0      | 7      | 0      | 0      | 6      | 4      | 10     | 0       | 136.0                  | 11.3    |
| 2015 Total      |      | 30     | 34     | 38.5   | 32     | 173    | 40     | 24     | 35     | 60     | 89.5   | 45     | 75      | 676.0                  |         |
| 2016 Total      |      | 114    | 55     | 27.75  | 34.1   | 5.25   | 9      | 18     | 29.25  | 18     | 29.5   | 29     | 0       | 368.9                  |         |
| 2015 Avg        |      | 4.29   | 4.86   | 5.50   | 4.57   | 24.71  | 5.71   | 3.43   | 5.00   | 8.57   | 12.79  | 6.43   | 10.71   |                        |         |
| 2016 Avg        |      | 16.29  | 7.86   | 3.96   | 4.87   | 0.75   | 1.29   | 2.57   | 4.18   | 2.57   | 4.21   | 4.14   | 0.00    |                        |         |
| 2015 Uptime %   |      | 97.45% | 96.96% | 96.88% | 97.40% | 85.29% | 96.75% | 98.14% | 97.02% | 94.90% | 92.74% | 95.98% | 93.91%  |                        | 95.29%  |
| 2016 Uptime %   |      | 89.82% | 95.09% | 97.85% | 97.10% | 99.55% | 99.27% | 98.39% | 97.73% | 98.47% | 97.49% | 97.53% | 100.00% |                        | 97.36%  |

Table 2. Overall machine uptime for 2016 is 97.4% up from 95.3% in 2015 [table 2]. The number of hours of downtime is determined for each month for each accelerator location. Uptime % is calculated:  $[1 - (\text{avg hours per month} / (\text{Bus Day per month} \times 8 \text{ hours/day}))] \times 100$ . The actual downtime has been reduced from 676 hours in 2015 to 368.9 hours in 2016.