# Chapter 14
# The Mutum-Paraná II Bridge Project (C)

**Abstract** The case description of this chapter is a last case exercise in a series of three exercises presented in Chaps. 6 and 11. It acts as an integrated exercise to get acquainted with the project control principles and special topics discussed in Part III of this book.
The primary goal of this fictitious case study is to get acquainted with the Earned Value Management approach to control projects. The goal of the student is to analyze the data of three projects in progress and to summarize their performance in the best possible way to the management committee. The data allows the incorporation of the Earned Schedule (ES) based Schedule Performance Index (SPI(t)) as an alternative to the traditional SPI metric that shows an unreliable behavior at the end of the project.
Similar to the first two case studies, the data in the case allows a deeper analysis based on the wishes and needs of the teacher and students, and contains data for the following special topics: the introduction of the schedule adherence concept, the use of schedule risk analysis to set action thresholds, the topological network structure as a driver for project control, etc.

## 14.1 Introduction

Since 1995, the Brazilian construction company Curitiba Pontes Ltd. has successfully completed large bridge and highway projects in the southern part of America. The company is known for its high level of experience in the construction area, its ability to work under challenging work conditions and tight schedules, and its profound knowledge of the project management discipline, which often resulted in projects completed on budget, on time and safely. Although its activities are spread out over different countries in South America, the main construction activities are located on the Brazilian market, with a strong focus on the bridge constructions located at and around the Paraná river.

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For more than a decade, José Silva Coelho was a well-established value in the Brazilian bridge construction company Curitiba Pontes Ltd.. Although he was known for his often pragmatic view on project management and control and his often conflicting meetings when presenting performance results, he has obtained excellent results as a project manager of various bridge construction projects during the past decade. The news about the leave of José Silva Coelho by the end of 2012 announced at the quarterly project performance meeting held at September 30, 2012 came as a shock to most members of its project team, but Curitiba Pontes Ltd. has gone through harder times during the last decade than the resignation of one of its most meritorious employees. The management committee finally decided that Carlos Garez has enough experience in the bridge construction sector to take over the role of the project manager of the project. As a young and enthusiastic employee of the company, Carlos accepted the challenge with a great amount of enthusiasm and became responsible for the three projects that were under the guidance of José. It is now end of March 2013, exactly 3 months ago that Carlos Garez took over from José Silva Coelho as a project manager and the time is near to report the quarterly project results of the three projects to the management committee.

## 14.2 The Project Portfolio

At the time of his resignation decision, José was mainly responsible for three bridge construction projects carried out with his young and enthusiastic permanent project team: the Mutum-Paraná II bridge project, the Iguaçú III bridge project and the Bermejo I bridge project. It is a long tradition for the Brazilian company Curitiba Pontes Ltd. that each bridge construction project gets a number, referring to the number of bridges they have constructed over that river in the past. All projects have roughly the same set of project activities but differ in their activity duration and cost estimates, in their project network logic and hence in their activity timing of execution. The schedules were constructed by José using a commercial software tool based on time and cost information about the individual activities. All projects used the same activity list template, as given in Table 14.4. The network logic, activity durations, resource requirements and corresponding costs depend on the project, and are displayed in Table 14.5.

The Mutum-Paraná II bridge project is the main construction project of the company, since it is part of a bigger highway construction project containing several subprojects. This highway was a promise from the government to the poor people of the interior to link their region to Buenos Aires. Therefore, large investments were made to stimulate the economy. The second longest river in South America after the Amazon, the Paraná River joins with the Paraguay and Uruguay Rivers before emptying into the Ro de la Plata estuary on its way to the Atlantic Ocean. The river begins its 3,032-mile (4,879-km) course in east-central Brazil. The Paraná flows mainly among high plateaus through Paraguay and Argentina.

The Iguaçú III bridge river project is the third bridge constructed by Curitiba Pontes Ltd. over the Iguaçú river. The Iguaçú river is formed by headstreams rising in the Serra do Mar near Curitiba. It winds generally westward through the uplands for about 820 miles (1,320 km) before joining the Paran River at the point where Argentina, Brazil, and Paraguay meet. It forms a small portion of the Brazilian-Argentine border. The width of the river at the point of the bridge is 131 m.

The Bermejo I bridge project is the most recent construction project to connect the two sides of the Bermejo river. The Bermejo River is a river in South America that travels a total of 1,450 km from Bolivia to the Paraguay River in Argentina. The river is born in a mountain range known as Sierra de Santa Victoria around coordinates near Tarija, a few kilometers southeast of Chaguaya in Bolivia, and not far from La Quiaca, Jujuy Province, Argentina. The river is generally called Bermejo in spite of its different names along its way, but it also has its own Native American names, such as Teuco and Ypitá. It is the first time that Curitiba Pontes Ltd. constructs a bridge over the Bermejo river.

Table 14.1 displays the expected project release times (with (*planned release date*) and without (*critical path finish*) resource leveling), the corresponding baseline schedule budget for the project portfolio as well as information on the project network structure. The structure of the project network, consisting of project activities and precedence relations, is measured by the degree of seriality/parallelism (SP), ranging from 0% (completely parallel) to 100% (serial network). Figure 14.1 presents a graphical timeline of the current portfolio under responsibility of José.

Carlos has received all documents from José but has had little time to discuss things in detail. He knew that José was a project manager who ranked experience above project tools and techniques, but was nevertheless impressed by the rich amount of planning and performance measurement data for the three projects.

Table 14.2 shows the quarterly performance results for the three projects. These results were used as reporting tools during the management committee meeting held end of March, June, September and December 2012. The table also contains the results of the analysis made by Carlos and his team member Orlando during the first quarter of March 2013, which will be presented during the next meeting. The next meeting, scheduled at April 03, 2013, is coming soon, and Carlos is eager to show that the results presented on the previous meeting should be put in perspective. Carlos does not understand the improving performance of the Mutum-Paraná II bridge project as shown by the Schedule Performance Index for March, 2013 (an increase from 65% to 92%). Based on what he has heard from the project team, he could only conclude that the figures mask a possible problem,

**Table 14.1** Network, time and cost information for the three projects

| Project | SP(%) | Baseline Start | Critical path Finish | Planned Release date | Budget(€) |
|---|---|---|---|---|---|
| Mutum-Paraná II | 29 | 06/02/2012 | 06/08/2012 | 21/01/2013 | 1,275,200 |
| Iguaçú III | 44 | 02/04/2012 | 07/01/2013 | 07/08/2013 | 1,267,200 |
| Bermejo I | 70 | 02/07/2012 | 31/07/2013 | 29/11/2013 | 1,246,400 |

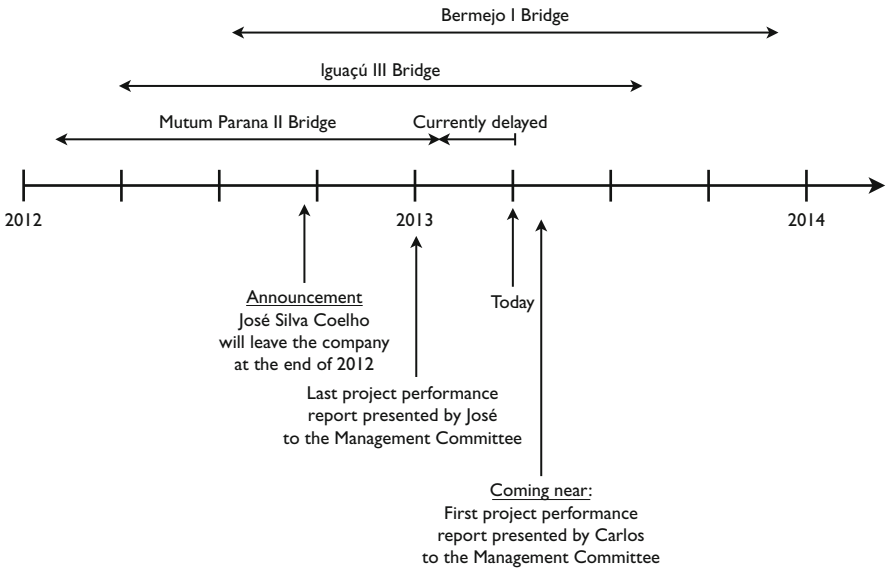


**Fig. 14.1** A graphical timeline for the current project portfolio

**Table 14.2** Overview of the main results reported to the management committee during the previous meetings

| | | 03/12 Approved | 06/12 Approved | 09/12 Approved | 12/12 Approved | 03/13 On agenda |
|---|---|---|---|---|---|---|
| Mutum-Paraná II | SPI | 0.53 | 0.69 | 0.65 | 0.65 | 0.92 |
| | SPI(t) | – | – | – | – | 0.71 |
| | CPI | 0.56 | 0.68 | 0.68 | 0.70 | 0.74 |
| Iguaçú III | SPI | n.a. | 1.10 | 1.27 | 1.04 | 0.97 |
| | SPI(t) | – | – | – | – | 0.98 |
| | CPI | n.a. | 1.25 | 1.18 | 99 | 0.96 |
| Bermejo I | SPI | n.a. | n.a. | 0.99 | 0.86 | 0.77 |
| | SPI(t) | – | – | – | – | 0.85 |
| | CPI | n.a. | n.a. | 85 | 0.83 | 0.79 |

or maybe the performance analysis was done in an incorrect way. He therefore decides to analyze all EVM tables in a more profound way, hoping to find out what really went wrong in the quarterly reports presented to the management board. He considers that as a crucial step for the future performance meetings to correctly understand the past.

The project performance results of Table 14.2 are completely based on the efforts taken by Orlando Carvalheiro, one of the project team members, who is experienced in monitoring project progress using Earned Value Management. Orlando, who has collaborated with José for many years, has made all detailed reports that were used

**Table 14.3** Monthly EVM metrics for the three projects used as internal performance communication tool

| | Mutum-Paraná II | | | Iguaçú III | | | Bermejo I | | |
|---|---|---|---|---|---|---|---|---|---|
| | PV(€) | AC(€) | EV(€) | PV(€) | AC(€) | EV(€) | PV(€) | AC(€) | EV(€) |
| 02/12 | 74,400 | 74,400 | 41,429 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 03/12 | 202,960 | 198,400 | 110,478 | n.a. | n.a. | n.a. | n.a. | n.a. | n.a. |
| 04/12 | 301,280 | 303,280 | 183,182 | 61,200 | 55,320 | 75,067 | n.a. | n.a. | n.a. |
| 05/12 | 381,200 | 401,680 | 265,800 | 102,800 | 108,720 | 140,357 | n.a. | n.a. | n.a. |
| 06/12 | 511,920 | 517,820 | 351,477 | 194,160 | 170,770 | 213,875 | n.a. | n.a. | n.a. |
| 07/12 | 617,200 | 623,420 | 430,246 | 233,040 | 241,700 | 314,246 | 41,600 | 41,600 | 34,577 |
| 08/12 | 769,520 | 739,420 | 516,674 | 331,440 | 312,360 | 403,044 | 83,690 | 94,090 | 78,313 |
| 09/12 | 865,360 | 819,420 | 560,077 | 385,840 | 412,950 | 488,731 | 126,950 | 148,220 | 126,400 |
| 10/12 | 982,560 | 903,170 | 608,722 | 470,000 | 503,730 | 571,103 | 179,600 | 198,150 | 177,269 |
| 11/12 | 1,183,040 | 1,039,750 | 713,745 | 598,960 | 635,730 | 662,138 | 234,340 | 251,170 | 214,952 |
| 12/12 | 1,252,480 | 1,166,200 | 813,486 | 704,560 | 741,330 | 734,966 | 296,340 | 305,570 | 253,694 |
| 01/13 | 1,275,200 | 1,253,240 | 891,427 | 801,200 | 830,850 | 818,668 | 366,130 | 370,420 | 300,056 |
| 02/13 | 1,275,200 | 1,391,590 | 990,400 | 865,840 | 888,930 | 860,004 | 450,860 | 436,790 | 348,519 |
| 03/13 | 1,275,200 | 1,594,150 | 1,174,055 | 940,160 | 952,180 | 915,262 | 561,420 | 546,290 | 432,350 |

as internal communication tools within his own team. Each quarter, a summary was handed to José for the quarterly management committee meeting. Carlos was intrigued by these detailed reports and committed himself to investigate all EVM metrics in detail in order to understand what has happened in the past for the three projects. These detailed reports can be found in Table 14.3.

## 14.3 The Management Committee Meeting

The main task that Carlos faces in the short run is the preparation of the project performance report for the next management committee meeting scheduled at April 3, 2013. Apart from putting the results from previous meetings in perspective, Carlos is motivated to show a new and improved way of reporting the project portfolio performance. Together with Orlando, he sets up a plan to perform extra analyses for each individual project as well as to give estimates about the progress of each activity. While the main focus should be on the performance of the three projects over the past, he also demands to the various members of his project team to calculate certain characteristics of the project, such as the risk profile of each project activity and the percentage completed for each activity at the current time. Table 14.6 displays the current project status measured at the end of March, 2013 with the three key metrics of earned value management and the percentage completed as estimated by the team members. Table 14.7 shows various time sensitivity measures for all project activities obtained by a classical schedule risk analysis tool performed on the project schedules before resource leveling (i.e. on the critical path based project schedules).

Carlos plans an internal meeting with his team, and honestly congratulates them with the rich amount of information that they gathered during the past quarters. He explains that the use of project performance reporting using EVM goes far beyond

the use of only the metrics. He explains that the three basic EVM metrics (planned value (PV), actual cost (AC) and earned value (EV)) can be used to calculate other, often more relevant metrics, and therefore provides additional information above the traditional SPI and CPI metrics used in the reports by José. Moreover, he explains that the task of the team is to throw a critical eye on the metrics and draw project specific conclusions to improve the actions that need to be taken in case problems arise.

Carlos gives an overview of the four main topics worth considering and stresses that these are outlined in order of importance:

- Reporting the correct time and cost performance. While the traditional CPI metric is often a reliable cost performance measure, he explains that the SPI often contains a flaw and can be extended to a more reliable measure. Due to the time criticality of the three projects, he asks Maria Mota Pereira, the account manager of Curitiba Pontes Ltd., to calculate extended SPI metrics, based on the Earned Schedule technique and the data from Table 14.6. Although Maria has never heard about this Earned Schedule technique, she accepts the job with great pleasure and immediately decides the wrap up the EVM metrics and look for this new Earned Schedule (ES) technique on the internet. The SPI(t) indicator, as shown in Table 14.2 for the first quarter of 2013 is one of those ES based metrics that was never used by José and is therefore new to the committee board and most members of Carlos' team.
- Analysis of dynamic information that measures the adherence to the project baseline schedule. At a project management conference, Carlos has learned about a possible analysis of potential threads and project impediments through the use of the so-called p-factor approach, which is a dynamic measure to calculate the schedule adherence based on EVM data. Carlos realizes that this is a completely new way of approaching EVM and is not sure about the benefits of this approach. For this reason, he decides that he will analyze this part himself, knowing that it might lead to unsuccessful results.
- Show potential problems related to the use of EVM management. Carlo briefly explains to the team that the use of performance metrics on the project level might lead to warning signals that are sometimes misleading or even completely wrong. He therefore calls their attention of a careful use and interpretation of performance metrics and highlights the importance of drilling down in the work breakdown structure and investigate potential problem or opportunities in individual project activities as warned by the project performance metric values. Since Maria Mota Pereira has already accepted a similar task, she volunteered to also take up this job.
- Integration of the time sensitivity results obtained by a schedule risk analysis (SRA) with EVM based performance reports in order to detect potential future project monitoring directions. Carlos conjectures that the sensitivity information of Table 14.7 and the network topology information displayed in Table 14.1 can be used to provide some general guidelines. Based on his experience in schedule

risk analysis and his technical background, Carlos decides that this would be a perfect job for Orlando Carvalheiro, the resource manager of the company.

## 14.4 The Agenda

Immediately after the internal team meeting, Carlos has sent an email to the chairman of the management committee explaining that he wants to throw a critical eye on the performance reports of last year and will present the newly quarterly performance results. To that purpose, he has put three items on the agenda of next meeting:

- Look back analysis: Analysis on the past project performance reports presented at the previous management committee meetings and put things in perspective (based on Tables 14.3 and 14.6)
- Current portfolio performance: Preparation of the performance report for the new quarterly management committee meeting based on an extended view of EVM metrics (based on the percentage completion (PC) estimates of Table 14.6)
- Go beyond the EVM metrics: Lessons learned and actions to be taken – what can we learn from these reports and how can we improve this communication? (based on information from all tables)

Carlos feels a healthy sense of nervousness, not only because of the rapid speed of the management committee deadline coming near, but also because he feels that he can put his stamp upon a completely new approach of project performance measurement, which, unlike the approach taken by José, sheds a completely new light on project monitoring in general and EVM in particular. Still 3 days to go from today, he knows that the successful finalization of all documents for the meeting heavily depends on the speed and quality of the analyses accepted by Orlando and Maria. Meanwhile, he thinks about the main topics he wants to present to the executive committee and decides to recapitulate the main EVM courses he had during his training to become a project manager at Curitiba Pontes Ltd.. While he is preparing his meeting reports, he suddenly starts thinking about the quote he has learned from the Nobel prize winning philosopher Bertrand Russell. “The greatest challenge to any thinker is stating the problem in a way that will allow a solution”. “It certainly is”, he thinks, while the deadline is coming near …

## 14.5 Appendix

All project files and tables are available in ProTrack or MS Excel format and can be downloaded from www.protrack.be/examples (Tables 14.4–14.7).

**Table 14.4** Activity list template used by Curitiba Pontes Ltd

| ID | Description |
|---|---|
| 1 | Preparatory work and move in |
| **Mobilization** | |
| 2 | Mobilize Pile Rig 1 |
| 3 | Mobilize Pile Rig 2 |
| 4 | Mobilize Pile Rig 3 |
| **Excavation** | |
| 5 | Excavate Abutment 1 |
| 6 | Excavate Abutment 2 |
| 7 | Excavate Abutment 3 |
| **Drive piles** | |
| 8 | Drive Piles Abutment 1 |
| 9 | Drive Piles Abutment 2 |
| 10 | Drive Piles Abutment 3 |
| **Demobilization** | |
| 11 | Demobolize Pile Rig 1 |
| 12 | Demobolize Pile Rig 2 |
| 13 | Demobolize Pile Rig 3 |
| 14 | Forms, Pour and Strip Footing 1 |
| 15 | Forms, Pour and Strip Footing 2 |
| 16 | Forms, Pour and Strip Footing 3 |
| **Abutment activities** | |
| 17 | Forms, Pour and Strip Abutment |
| 18 | Forms, Pour and Strip Abutment |
| 19 | Forms, Pour and Strip Abutment |
| 20 | Backfill Abutment 1 |
| 21 | Backfill Abutment 2 |
| 22 | Backfill Abutment 3 |
| 23 | Set Girders and Forms Deck 1–2 |
| 24 | Set Girders and Forms Deck 2–3 |
| **Finishing work** | |
| 25 | Pour Deck |
| 26 | Saw Joints |
| 27 | Strip Deck and Rub Concrete |
| 28 | Clean Up and Final Inspection |

**Table 14.5** Activity information and the network logic for the three projects

| | Mutum-Paraná II | | | Iguaçú III | | | Bermejo I | | |
|---|---|---|---|---|---|---|---|---|---|
| ID | Predecessors | Time(w) | Cost(€) | Predecessors | Time(w) | Cost(€) | Predecessors | Time(w) | Cost(€) |
| 1 | – | 6 | 148,800 | – | 10 | 104,000 | – | 8 | 83,200 |
| 2 | 1SS+2w | 1 | 19,600 | 1SS+2w | 1 | 19,600 | 1SS+2w | 1 | 19,600 |
| 3 | 1FS+5w | 1 | 23,600 | 1FS+5w;2FS+1w | 1 | 23,600 | 1FS+5w;2FS+1w | 1 | 23,600 |
| 4 | 1FS+5w | 1 | 22,000 | 1FS+5w;3FS+1w | 1 | 22,000 | 1FS+5w;3FS+1w | 1 | 22,000 |
| 5 | 1FS | 1 | 10,400 | 1FS | 1 | 10,400 | 1FS;4FS | 1 | 10,400 |
| 6 | 1FS+8w | 1 | 10,400 | 1FS+8w | 1 | 10,400 | 1FS+8w ;5FS | 1 | 10,400 |
| 7 | 1FS+8w | 1 | 10,400 | 1FS+8w | 1 | 10,400 | 1FS+8w ;6FS | 1 | 10,400 |
| 8 | 2FS;5FS+3w | 3 | 60,000 | 2FS;5FS+3w | 6 | 81,600 | 2FS;5FS+3w | 6 | 81,600 |
| 9 | 3FS;6SS+6w | 3 | 60,000 | 3FS;6SS+6w | 6 | 81,600 | 3FS;6SS+6w;17FS;19FS | 6 | 81,600 |
| 10 | 4FS;7SS+3w | 1 | 20,000 | 4FS;7SS+3w | 3 | 40,800 | 4FS;7SS+3w | 3 | 40,800 |
| 11 | 8FS | 1 | 21,200 | 8FS | 1 | 21,200 | 8FS | 1 | 21,200 |
| 12 | 9FS | 4 | 104,000 | 9FS | 4 | 104,000 | 9FS | 4 | 104,000 |
| 13 | 10FS | 4 | 84,800 | 10FS | 4 | 84,800 | 10FS | 4 | 84,800 |
| 14 | 8FS | 1 | 24,000 | 8FS;11FS+1w | 1 | 24,000 | 8FS;11FS+1w | 1 | 24,000 |
| 15 | 9FS | 8 | 211,200 | 9FS;12FS+1w | 8 | 211,200 | 9FS;12FS+1w | 8 | 211,200 |
| 16 | 10FS | 1 | 24,000 | 10FS;13FS+1w | 1 | 24,000 | 10FS;13FS+1w | 1 | 24,000 |
| 17 | 11FS;14FS | 2 | 78,400 | 11FS;14FS | 4 | 73,600 | 11FS;14FS | 4 | 73,600 |
| 18 | 12FS;15FS | 1 | 44,800 | 12FS;15FS | 2 | 46,400 | 12FS;15FS | 2 | 46,400 |
| 19 | 13FS;16FS | 2 | 78,400 | 13FS;16FS | 4 | 73,600 | 13FS;16FS | 4 | 73,600 |
| 20 | 17FS | 4 | 25,600 | 17FS | 4 | 25,600 | 17FS | 4 | 25,600 |
| 21 | 18FS | 2 | 12,800 | 18FS | 2 | 12,800 | 18FS | 2 | 12,800 |
| 22 | 19FS | 3 | 19,200 | 19FS | 3 | 19,200 | 19FS | 3 | 19,200 |
| 23 | 17FS;18FS | 2 | 56,000 | 17FS;18FS | 2 | 46,400 | 17FS;18FS | 2 | 46,400 |
| 24 | 18FS;19FS | 2 | 56,000 | 18FS; 19FS | 2 | 46,400 | 18FS; 19FS | 2 | 46,400 |
| 25 | 23SS+1w;24SS+1w | 1 | 25,600 | 23SS+1w;24SS+1w | 1 | 25,600 | 23SS+1w;24SS+1w | 1 | 25,600 |
| 26 | 25FS+1w | 2 | 3,200 | 25FS+1w | 2 | 3,200 | 25FS+1w | 2 | 3,200 |
| 27 | 25FS+2w | 1 | 11,200 | 25FS+2w;26FS | 1 | 11,200 | 25FS+2w;26FS | 1 | 11,200 |
| 28 | 20FS;21FS;22FS; 26FS;27FF+2w | 1 | 9,600 | 20FS;21FS;22FS; 26FS;27FF+2w | 1 | 9,600 | 20FS;21FS;22FS; 26FS;27FF+2w | 1 | 9,600 |
| | | | 1,275,200 | | | 1,267,200 | | | 1,246,400 |

**Table 14.6** Status report of the three projects at 29/03/2013

| | Mutum-Paraná II | | | | Iguaçú III | | | | Bermejo I | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | PV(€) | AC(€) | EV(€) | PC(%) | PV(€) | AC(€) | EV(€) | PC(%) | PV(€) | AC(€) | EV(€) | PC(%) |
| 1 | 148,800 | 267,220 | 148,800 | 100 | 104,000 | 78,000 | 104,000 | 100 | 83,200 | 100,100 | 83,200 | 100 |
| 2 | 19,600 | 34,300 | 19,600 | 100 | 19,600 | 13,720 | 19,600 | 100 | 19,600 | 18,620 | 19,600 | 100 |
| 3 | 23,600 | 23,600 | 23,600 | 100 | 23,600 | 21,830 | 23,600 | 100 | 23,600 | 29,500 | 23,600 | 100 |
| 4 | 22,000 | 22,000 | 22,000 | 100 | 22,000 | 14,300 | 22,000 | 100 | 22,000 | 19,250 | 22,000 | 100 |
| 5 | 10,400 | 11,960 | 10,400 | 100 | 10,400 | 13,520 | 10,400 | 100 | 10,400 | 13,520 | 10,400 | 100 |
| 6 | 10,400 | 5,980 | 10,400 | 100 | 10,400 | 10,400 | 10,400 | 100 | 10,400 | 5,460 | 10,400 | 100 |
| 7 | 10,400 | 12,220 | 10,400 | 100 | 10,400 | 6,760 | 10,400 | 100 | 10,400 | 15,080 | 10,400 | 100 |
| 8 | 60,000 | 111,500 | 60,000 | 100 | 81,600 | 116,620 | 81,600 | 100 | 81,600 | 114,580 | 81,600 | 100 |
| 9 | 60,000 | 78,500 | 60,000 | 100 | 81,600 | 66,980 | 81,600 | 100 | 0 | 0 | 0 | 0 |
| 10 | 20,000 | 36,500 | 20,000 | 100 | 40,800 | 37,060 | 40,800 | 100 | 40,800 | 58,140 | 40,800 | 100 |
| 11 | 21,200 | 21,730 | 21,200 | 100 | 21,200 | 19,610 | 21,200 | 100 | 21,200 | 29,150 | 21,200 | 100 |
| 12 | 104,000 | 137,150 | 104,000 | 100 | 104,000 | 124,150 | 104,000 | 100 | 0 | 0 | 0 | 0 |
| 13 | 84,800 | 89,570 | 84,800 | 100 | 84,800 | 53,530 | 84,800 | 100 | 84,800 | 111,830 | 84,800 | 100 |
| 14 | 24,000 | 33,600 | 24,000 | 100 | 24,000 | 4,200 | 6,462 | 27 | 24,000 | 30,600 | 24,000 | 100 |
| 15 | 211,200 | 283,140 | 211,200 | 100 | 211,200 | 306,240 | 211,200 | 100 | 0 | 0 | 0 | 0 |
| 16 | 24,000 | 37,200 | 24,000 | 100 | 24,000 | 12,000 | 24,000 | 100 | 24,000 | 0 | 0 | 0 |
| 17 | 78,400 | 35,280 | 78,400 | 100 | 7,360 | 0 | 0 | 0 | 73,600 | 460 | 350 | 0 |
| 18 | 44,800 | 52,640 | 44,800 | 100 | 46,400 | 38,860 | 46,400 | 100 | 0 | 0 | 0 | 0 |
| 19 | 78,400 | 116,620 | 78,400 | 100 | 0 | 0 | 0 | 0 | 18,860 | 0 | 0 | 0 |
| 20 | 25,600 | 26,240 | 19,259 | 75 | 0 | 0 | 0 | 0 | 12,960 | 0 | 0 | 0 |
| 21 | 12,800 | 16,160 | 12,800 | 100 | 12,800 | 14,400 | 12,800 | 100 | 0 | 0 | 0 | 0 |
| 22 | 19,200 | 26,240 | 17,397 | 91 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 56,000 | 95,900 | 56,000 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | 56,000 | 18,900 | 12,600 | 22 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 25 | 25,600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 26 | 3,200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 27 | 11,200 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 | 9,600 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Table 14.7** Time sensitivity (in %, based on SRA without resource constraints)

| | | Mutum-Paraná II | | | | Iguaçú III | | | | Bermejo I | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Risk class | CI | SI | SSI | CRI | CI | SI | SSI | CRI | CI | SI | SSI | CRI |
| 1 | Chaos | 100 | 100 | 81.55 | 84.95 | 100 | 100 | 85.44 | 88.31 | 100 | 100 | 75.47 | 79.59 |
| 2 | Foreseen uncertainty (+) | 0 | 9.36 | 0 | 3.2 | 0 | 14.96 | 0 | 0.69 | 0 | 33.56 | 0 | 3.1 |
| 3 | Foreseen uncertainty (+) | 0 | 39.47 | 0 | 4.84 | 0 | 39.65 | 0 | 6.43 | 100 | 100 | 3.88 | 8.23 |
| 4 | Foreseen uncertainty (+) | 0 | 13.72 | 0 | 3.8 | 0 | 12.24 | 0 | 4.4 | 100 | 100 | 4.35 | 11.82 |
| 5 | Unforeseen uncertainty | 0 | 25.02 | 0 | 3.8 | 0 | 16.97 | 0 | 6.68 | 100 | 100 | 6.38 | 1.93 |
| 6 | Unforeseen uncertainty | 95 | 99.06 | 8.3 | 12.71 | 100 | 100 | 5.65 | 11.68 | 87 | 96.38 | 5.42 | 15.5 |
| 7 | Unforeseen uncertainty | 5 | 42.53 | 0.39 | 7.67 | 0 | 18.65 | 0 | 6.32 | 87 | 96.37 | 4.87 | 4.29 |
| 8 | Foreseen uncertainty (+) | 0 | 50.5 | 0 | 0.89 | 0 | 55.33 | 0 | 5.75 | 13 | 87.51 | 3.44 | 0.43 |
| 9 | Foreseen uncertainty (+) | 95 | 99.6 | 15.63 | 7.96 | 100 | 100 | 21.38 | 15.87 | 100 | 100 | 23.59 | 20.03 |
| 10 | Foreseen uncertainty (+) | 5 | 42.54 | 0.28 | 3.34 | 0 | 40.4 | 0 | 5.26 | 87 | 98.41 | 10.52 | 10.21 |
| 11 | Variation | 0 | 24.77 | 0 | 4.86 | 0 | 16.96 | 0 | 2.58 | 13 | 58.87 | 0.59 | 3.17 |
| 12 | Variation | 0 | 50.19 | 0 | 11.17 | 100 | 100 | 15.15 | 25.1 | 100 | 100 | 16.71 | 26.7 |
| 13 | Variation | 5 | 72.21 | 1.21 | 8.12 | 0 | 47.06 | 0 | 6.47 | 87 | 98.67 | 15 | 22.45 |
| 14 | Variation | 0 | 24.72 | 0 | 9.33 | 0 | 16.93 | 0 | 8.21 | 13 | 59.05 | 0.58 | 6.17 |
| 15 | Variation | 95 | 99.82 | 46.69 | 53.36 | 100 | 100 | 31.77 | 40.51 | 100 | 100 | 35.05 | 43.99 |
| 16 | Variation | 0 | 18.11 | 0 | 4.92 | 0 | 18.57 | 0 | 4.97 | 87 | 96.35 | 3.88 | 3.55 |
| 17 | Variation | 0 | 40.21 | 0 | 9.41 | 0 | 44.92 | 0 | 5.04 | 13 | 82.69 | 2.37 | 9.66 |
| 18 | Variation | 95 | 99.01 | 5.99 | 13.6 | 100 | 100 | 8.14 | 14.65 | 100 | 100 | 8.98 | 17.03 |
| 19 | Variation | 5 | 57.77 | 0.63 | 8.14 | 0 | 47.14 | 0 | 6.44 | 87 | 98.69 | 15.81 | 22.01 |
| 20 | Unforeseen uncertainty | 0 | 44.28 | 0 | 9.11 | 0 | 33.49 | 0 | 8.06 | 0 | 13.86 | 0 | 4.13 |
| 21 | Unforeseen uncertainty | 0 | 32.67 | 0 | 18.45 | 0 | 28.11 | 0 | 19.44 | 0 | 28.13 | 0 | 16.04 |
| 22 | Unforeseen uncertainty | 0 | 39.52 | 0 | 12.57 | 0 | 25.95 | 0 | 16.25 | 0 | 10.64 | 0 | 13.16 |
| 23 | Unforeseen uncertainty | 95 | 99.41 | 16.88 | 7.1 | 100 | 100 | 11.48 | 10.53 | 100 | 100 | 12.67 | 11.69 |
| 24 | Unforeseen uncertainty | 100 | 100 | 15.72 | 16.03 | 100 | 100 | 10.16 | 16.85 | 100 | 100 | 11.21 | 17.86 |
| 25 | Variation | 100 | 100 | 5.51 | 26.26 | 100 | 100 | 3.56 | 24.84 | 100 | 100 | 3.93 | 28.71 |
| 26 | Variation | 0 | 65.72 | 0 | 11.61 | 100 | 100 | 8.87 | 18.57 | 100 | 100 | 9.78 | 16.92 |
| 27 | Variation | 100 | 100 | 6.89 | 21.2 | 100 | 100 | 4.45 | 17.02 | 100 | 100 | 4.91 | 18.96 |
| 28 | Foreseen uncertainty (−) | 100 | 100 | 5.89 | 8.92 | 100 | 100 | 3.81 | 6.78 | 100 | 100 | 4.2 | 1.64 |