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EVM Analysis with Primavera

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Abstract - *Earned Value Management is a project management tool that uses information based on cost, schedule and work performance to define the current status of the project. EVM helps the manager to extrapolate current trends to predict their likely final effect. This method is proved effective in cost control. The Primavera is project management software which enables users to track and analyze performance of project. The Report wizard in primavera creates customized reports that extract specific data from its database. The paper outlines the basic principles of the EVM & how it can be used successfully for particular project with help of primavera. Also some benefits and complications of EVM with reference to Indian construction sector.*

Key Words: **Earn value, Earn Value Analysis, Project Management, Primavera, Earn Value Management**

1.INTRODUCTION

"If you can't measure it, you can't manage it". Whether one trusts the validity of this common phrase most of the time or all of the time, measuring the true progress of a project presents a formidable task. Given a baseline plan, projects typically report a measure of the completed work and compare it to that scheduled. Similarly, most projects can and do measure the current cost and compare it to the planned spending. But for a more comprehensive view, how does one measure the progress of a project against the triple constraint of cost, schedule, and scope? The two simple measures above separate schedule and cost and include scope only indirectly, as a function of schedule. In this framework, the mere contemplation of the budgeted cost of work performed cries out for an immediate comparison to the actual cost. Earned value analysis next brings the schedule into this common comparison basis by asking how much spending should have occurred, i.e., according to a project's schedule, at the specific time of any comparison.

1.1 Earn Value Management

Earn Value is the measurement of work that project manager uses to evaluate the progress of a project based on the cost of work performed until the project status date. When a project's earned value is calculated, by default it compares your original cost estimates to the actual work performed so as to determine whether your project is on budget or not. Earn value is a measurement that indicates how much of the budget should have been spent, when comparing the cost of work performed to the baseline cost for the task, resource or assignment The Earned Value method has been developed as a tool facilitating project progress control. It is used for determining a project's status (is it behind or ahead of schedule? is it over or under budget?) and the scale of current variances from the plan. Moreover, it allows a project manager to make inferences on the final effect of the project in terms of cost and, to some extent, in terms of duration, by extrapolating current trends.

The method is simple: it assumes a simplified model of a project, and calculations require nothing more than four basic arithmetic operations. However, the method has been recognized as a useful tool by many practitioners and government agencies and has become a standard in project management. It proved to be versatile enough to be applied to any type of a project, ranging from defense schemes worth millions and extending on many years to minor IT projects. The analysis can be conducted on any level of work breakdown structure and used by both clients and contractors. The method, if to be used efficiently, requires a disciplined approach to collection of data on project cost and progress (on weekly basis) and the findings are to be processed immediately. The purpose is to detect any deviation as soon as possible, so that there is enough time to asses if the deviation is dangerous for the project and, if necessary, to take corrective actions.

1.2 The Concept of EVM

1. Input data

Figure 4.1 presents the idea of the Earned Value project control. The analysis requires following inputs:

BCWS - Budgeted Cost of Works Scheduled - the baseline for the analysis, cumulated planned costs related to time of their incurrence;

BCWP - Budgeted Cost of Work Performed - a measure of physical progress of works expressed by cumulated planned cost of works actually done related to time, it is also called Earned Value (like the method it is used by);

ACWP – Actual Cost of Work Performed - cumulated amount payable for works done related to time;

BAC - Budget at Completion - total planned cost of the whole project, it equals BCWS at the planned finish;

T – Planned duration of Project

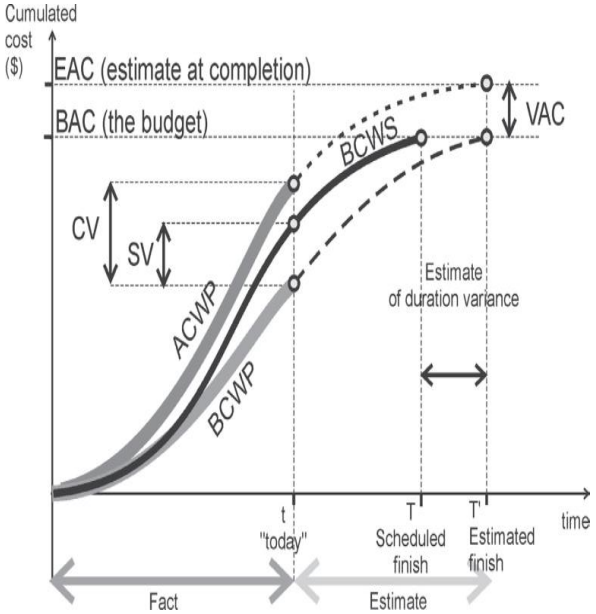


Fig.4.1. *Earned Value* curves; this project is currently ("today") over budget and behind schedule.

2. Project status indicators

PC - Percentage Complete:

$$PC = \frac{BCWP}{BAC}$$

CV - Cost Variance - a measure of deviation between planned and actual cost of works done until the date of recording progress in money units. If negative, it indicates that the project is over budget:

$$CV = ACWP - BCWP$$

To capture the scale of deviation, it is often expressed as a fraction of the budgeted cost of works performed:

$$CV\% = \frac{CV}{BCWP} \times 100\%$$

SV - Schedule Variance - a measure of deviation between the actual progress and the planned progress. Though it is interpreted as time deviation, it is expressed in money units. In other words, it is the difference between the planned cost of works that have been done and planned cost of works that should have been done by the reporting date. If negative, it indicates a delay:

$$SV = BCWP - BCWS$$

To address any distortion caused by the relative value of activities, it is expressed as a fraction of BCWS:

$$SV\% = \frac{SV}{BCWS} \times 100\%$$

CPI - Cost Performance Index - compares the planned and actual value of works done, if less than 1, it indicates that the project has consumed more money than planned, if greater than 1, there have been savings.

$$CPI = \frac{BCWP}{ACWP}$$

SPI - Schedule Performance Index - compares the planned cost of works done with planned cost of works planned; if less than 1, it indicates a delay:

$$SPI = \frac{BCWP}{BCWS}$$

3. Earned Value "forecasting" parameters

EAC - Estimate at Completion - is calculated at the date of reporting progress to serve as an estimate of the effect of deviations cumulated from the project's start on the total project cost, so it informs how much the project is going to be in the end, if the cost performance index CPI stays the same:

$$EAC = \frac{BAC}{CPI}$$

It is clear that EAC is a simple linear extrapolation of current tendencies. It does not allow for any future risks or effects of corrective measures, so it is not a proper forecast. Nevertheless, EAC indicates the potential scale of cost problems. As the Earned Value method requires frequent progress checks from the very beginning of a project, an early EAC-based constitution that current tendencies are likely to double the cost are likely to provide a valuable warning signal and trigger rectifying actions when it is still time.

EAC is not necessarily based on the assumption that future costs are going to follow the today's pattern. Other scenarios can be considered but, as the method rests upon a simplified model of a project, linear extrapolation is a rule and it proves to be adequate. The general EAC formula allows for a number of simple scenarios:

$$\text{EAC} = \text{ACWP} + \frac{BAC - BCWP}{PF}$$

i.e. EAC is a sum of costs already committed and the reminder of the budget adjusted by a factor (PF) that reflects the relationship between the project's future and its past. This can be project-specific. Scenarios considered most often are as follows:

1. the cost of remaining task is going to be as planned, i.e. future costs are not related to current costs, PF=1, so:

$$EAC = BAC + CV$$

2. the cost of remaining tasks is going to stay in proportion to current CPI as in equation (8); it ignores the real-life time-cost relationship (if a project is to be accelerated, it usually requires more money);
3. the cost of remaining tasks will be related to current tendencies of both schedule and cost performance, so the PF is a Critical Ratio (CR), called also a Schedule Cost Ratio (SCR):

$$SCI = CPI \times SPI$$

Another measure used for forecasting (or rather for simple extrapolation) is TCPI (To Complete Performance Index) - a value of cost performance index that is to be maintained from now on if the project is to be completed to budget. In other words, TCPI is a proportion between the

remaining work (expressed in terms of budgeted costs) and the money left from the budget:

$$TCPI = \frac{BAC - BCWP}{BAC - ACWP}$$

If it is much higher than 1 and the current CPI, it indicates the scale of effort needed for searching for economies.

Table No - 1

Name	Interpretation
CV	NEGATIVE is over budget, POSITIVE is under budget.
SV	NEGATIVE is behind schedule, POSITIVE is ahead of schedule.
CPI	Less than 1 poor performance Greater than 1 good performance.
SPI	Less than 1 poor performance Greater than 1 good performance.
EAC	As of now how much do we expect the total project to cost • Used if no variances from the BAC have occurred. • Actual plus a new estimate for remaining work. Used when original estimate was fundamentally flawed. • Actual to date plus remaining budget. Used when current variances are atypical. • Actual to date plus remaining budget modified by performance. When current variances are typical.
ETC	How much more will the project cost?
VAC	How much over budget will we be at the end of the project?

1.3 Application of EVM

1. EVM provides project managers and the organizations with triggers or early warning signals that allow them to take timely actions in response to indicators of poor performance and enhance the opportunities for project success. Such indicators have been found to be reliable as early as 15% into a project. Better planning & resource allocation associated with the early period of a project might be the cause of this reliability.
2. EVM can be used for progress payments to contractors based on the EV of contracted or outsourced work. Because such contractual arrangements create legal & financial obligations it is important to consider the method specified for evaluating progress.
3. For long terms projects it may be appropriate to consider the incorporating the time value of money & time discounted cash flows into EVM. Inflation can be explicitly considered in EVM and the inflation variance can be calculated. However, these considerations add complexity to the method and may be justifiable only for very long term projects or in very high inflation periods or economics.

1.4 Advantages of EVM

EVM keeps the management on their toes. As EVM is done periodically, management tries to make sure that all project parameter on track. It measures & predicts the progress in the ongoing project in terms of work, time & money. It also allows the manager to be on time & on budget. The Cost Performance Index (CPI) and Schedule Performance Index (SPI) provide early warning signals. It is mostly suitable for the huge construction project. EVM timely performance measurement make sure that steps can be taken to the bring project back on track before it's too late.

1.5 Limitations of EVM

While doing the earn value analysis, quality is not taken into consideration. Cost of implementing Earned value management causes managers not to use it extensively. Generally, software is required and coordination between different departments should be good to achieve the goal. It is required to be carried out at different stages as the uncertainty may occur any time throughout the project.

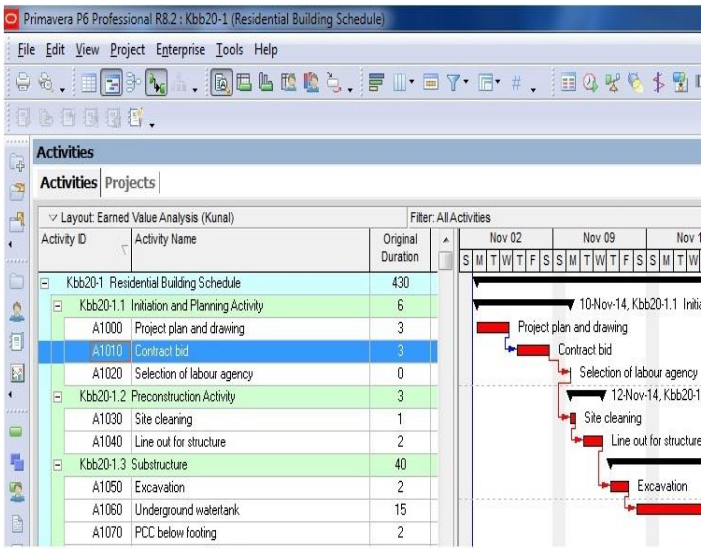
2. EVM by Primavera

2.1 Primavera

The Primavera enables users to track and analyze performance. It is a multiuser, multi-project system with scheduling and resource control capabilities supporting multitier project hierarchies, resource scheduling with a focus on roles and skills, recording of actual data, customizable views, and user-definable data. It supports an enterprise project structure (EPS) with an unlimited number of projects, activities, baselines, resources, work breakdown structures (WBS), organizational breakdown structures (OBS), user-defined codes, and critical-path-method (CPM) scheduling and resource leveling. Primavera also provides centralized resource management. This includes resource timesheet approval and the ability to communicate with project resources that use the Progress Reporter. In addition, Primavera provides integrated risk management, issue tracking and management by threshold. The tracking feature enables users to perform dynamic cross project rollups of cost, schedule, and earned value. Project work products and documents can be assigned to activities and managed centrally. The Report Wizard creates customized reports that extract specific data from its database.

Steps of using Primavera for Earn Value

1) Add Activities, Tie Logic, Set % Complete to Physical

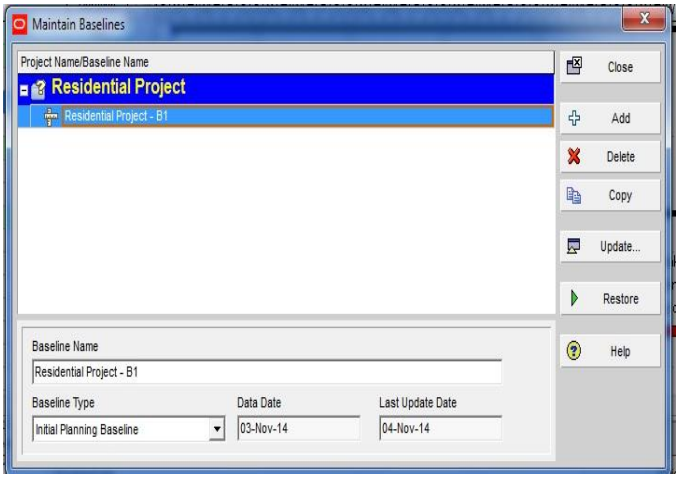


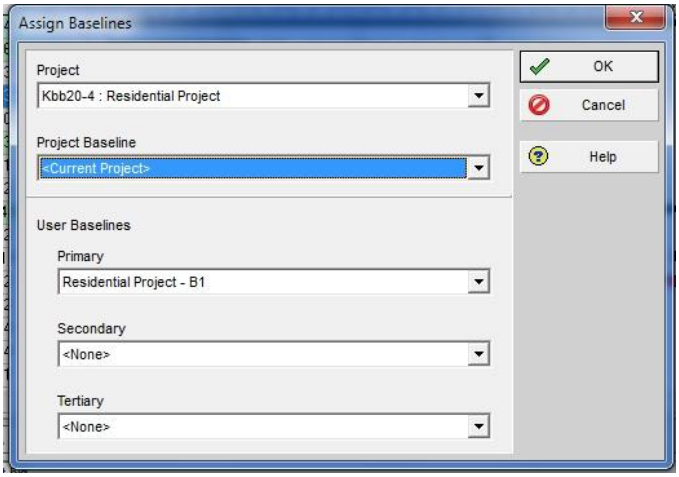
2) Add Resource Assignments

Display: All Active Resources

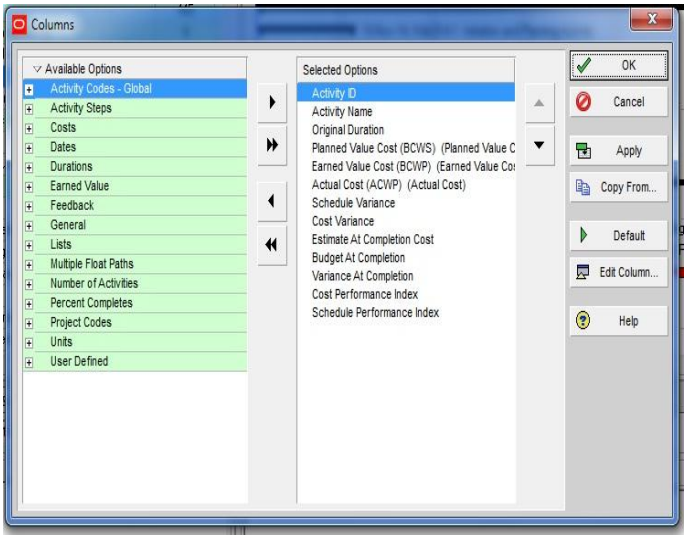
Resource ID	Resource Name	Resource Type	Standard Rate	Unit of Measure
R	Excavation in Hard Rock with JCB	Material	Rs700.00/CuM	Cubic Meter
R-40	Soling	Material	Rs780.00/CuM	Cubic Meter
R-1	Excavation in Soft Soil	Material	Rs110.00/CuM	Cubic Meter
R-2	Murum Brought From Outside	Material	Rs505.00/CuM	Cubic Meter
R-3	Concrete M-10 (PCC)	Material	Rs3,539.00/CuM	Cubic Meter
R-4	Concrete M-20 (Beams & Parabolas)	Material	Rs7,469.00/CuM	Cubic Meter
R-5	Concrete M-20 (Slab & Staircase)	Material	Rs8,843.00/CuM	Cubic Meter
R-6	Concrete M-25 (Footing)	Material	Rs5,344.00/CuM	Cubic Meter
R-7	Concrete M-25 (Lift)	Material	Rs8,300.00/CuM	Cubic Meter
R-8	Concrete M-25 (Column)	Material	Rs8,088.00/CuM	Cubic Meter
R-9	Reinforcement Steel	Material	Rs53,000.00/tons	Tons
R-10	Brick Work 6"	Material	Rs5,335.00/CuM	Cubic Meter
R-11	Brick Work 4"	Material	Rs1,173.00/SqM	Square Meter
R-12	Internal Plaster - Nerru Finish	Material	Rs270.00/SqM	Square Meter
R-13	Ceilling POP	Material	Rs150.00/SqM	Square Meter
R-14	External Plaster	Material	Rs378.00/SqM	Square Meter

3) Maintain Baseline and Assign to Project

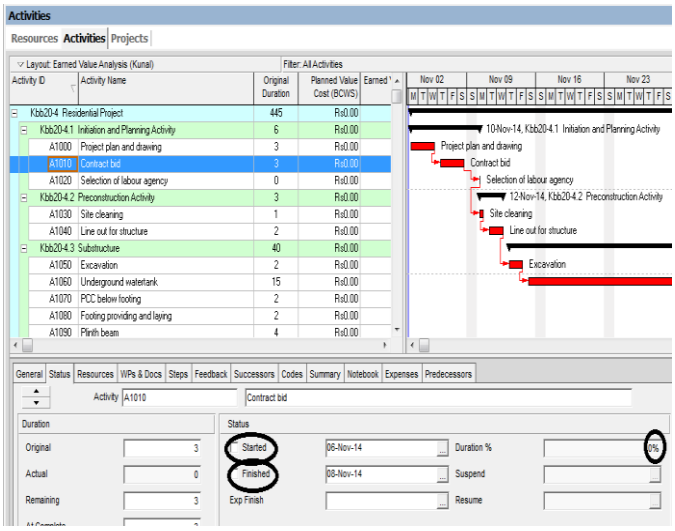




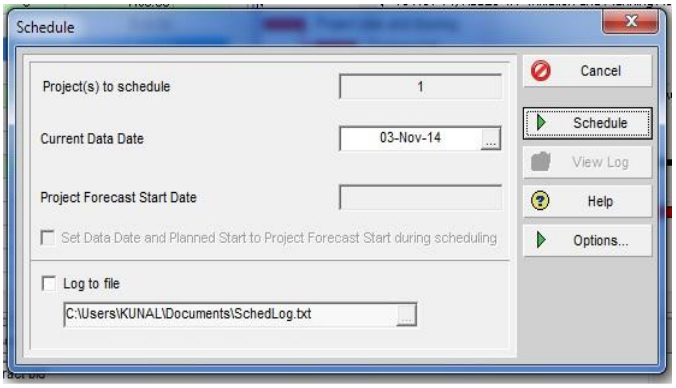
4) Customize Columns for analysis



5) Update Physical % Complete, Update Resource Actual Units (Or Expenses)



6) Schedule Project, Advance Data Date



Finally, we can analyses earn value.

5.Earn Value Report

WBS Activity ID	Activity Name	Planned Value Cost (BCWS)	Earned Value Cost (BCWP)	Actual Cost (ACWP)	Schedule Variance	Cost Variance	Estimate At Completion Cost	Budget At Completion	Variance At Completion	Cost Performance Index	Schedule Performance Index
Kbb20-5	Residential Project Reflection										
Kbb20-5.1	Initiation and Planning Activity										
A1020	Selection of labour agency	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	0.00	0.00
A1000	Project plan and drawing	Rs800,000.00	Rs800,000.00	Rs0.00	Rs0.00	Rs800,000.00	Rs0.00	Rs800,000.00	Rs800,000.00	0.00	1.00
A1010	Contract bid	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	0.00	0.00
Subtotal		Rs800,000.00	Rs800,000.00	Rs0.00	Rs0.00	Rs800,000.00	Rs0.00	Rs800,000.00	Rs800,000.00	0.00	1.00
Kbb20-5.2	Preconstruction Activity										
A1030	Site cleaning	Rs1,650.00	Rs1,650.00	Rs1,650.00	Rs0.00	Rs0.00	Rs1,650.00	Rs1,650.00	Rs0.00	1.00	1.00
A1040	Line out for structure	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	Rs0.00	0.00	0.00
Subtotal		Rs1,650.00	Rs1,650.00	Rs1,650.00	Rs0.00	Rs0.00	Rs1,650.00	Rs1,650.00	Rs0.00	1.00	1.00
Kbb20-5.3	Substructure										
A1090	Underground watertank	Rs125,000.00	Rs125,000.00	Rs0.00	Rs0.00	Rs125,000.00	Rs0.00	Rs125,000.00	Rs125,000.00	0.00	1.00
A1120	Soling and compaction	Rs7,527.00	Rs7,527.00	Rs7,527.00	Rs0.00	Rs0.00	Rs7,527.00	Rs7,527.00	Rs0.00	1.00	1.00
A1090	Plinth beam	Rs115,545.43	Rs115,545.43	Rs115,545.43	Rs0.00	Rs0.00	Rs115,545.43	Rs115,545.43	Rs0.00	1.00	1.00
A1070	PCC below footing	Rs40,827.72	Rs40,827.72	Rs40,827.72	Rs0.00	Rs0.00	Rs40,827.72	Rs40,827.72	Rs0.00	1.00	1.00
A1130	PCC at floor	Rs854,987.01	Rs854,987.01	Rs854,987.01	Rs0.00	Rs0.00	Rs854,987.01	Rs854,987.01	Rs0.00	1.00	1.00
A1080	Footing providing and laying	Rs246,382.16	Rs246,382.16	Rs249,434.00	Rs0.00	(Rs3,051.84)	Rs249,434.00	Rs246,382.16	(Rs3,051.84)	0.99	1.00
A1050	Excavation	Rs91,199.70	Rs91,199.70	Rs91,199.70	Rs0.00	Rs0.00	Rs91,199.70	Rs91,199.70	Rs0.00	1.00	1.00
A1100	Backfilling and compaction	Rs20,475.00	Rs20,475.00	Rs20,475.00	Rs0.00	Rs0.00	Rs20,475.00	Rs20,475.00	Rs0.00	1.00	1.00
A1110	Antitermite treatment	Rs10,000.00	Rs10,000.00	Rs10,000.00	Rs0.00	Rs0.00	Rs10,000.00	Rs10,000.00	Rs0.00	1.00	1.00
Subtotal		Rs1,511,744.02	Rs1,511,744.02	Rs1,389,795.86	Rs0.00	Rs121,948.16	Rs1,389,795.86	Rs1,511,744.02	Rs121,948.16	1.09	1.00

3. CONCLUSIONS

Earned value performance reporting is intended to forewarn management of potential cost and schedule problems so that corrective action may be implemented before problems become critical. A fast turn-around from project status review to reporting the results will give management more time to devise alternate plans. Utilization of the earned value technique for project control will result in better assessment of activity time and budget requirements. Management will be better informed to distribute work load. Improved productivity can result through constant feedback to management on cost and schedule performance, thereby, providing the opportunity to concentrate on problem areas. However, the earned value technique by itself is not enough for good project control. It is a systematic procedure for performance measurement which can be effective only if it is supported by good cost and schedule control systems.

The reason for using Earned Value is tied closely to what Earned Value is. While the manipulation of the vast amount of data that is involved may seem daunting, the use of available computer tools designed for the purpose, make the implementation a relatively simple book procedure. Earned Value simply represents the budgeted value of the completed work and is directly related to the percent complete of the activity or WBS element under consideration.

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