

Solution Analysis and Design

Product Availability in Captive Aisle Systems

Operations personnel have an inherent fear of not being able to access inventory in a captive aisle system. While this is a valid concern, there are many ways to reduce the possibility of trapped inventory during potential equipment downtime. Applying these techniques will result in very high probability of product availability.

Design Considerations:

Automated Storage & Retrieval Systems (ASRS) with captive aisle technology are used in mission critical applications across all industry segments. For each of these applications, not having access to inventory is simply unacceptable. In all things there is a certain “probability” that something will occur. In this whitepaper we apply quantitative metrics to the probability of product unavailability in a captive aisle system.

Product unavailability in a captive aisle system is driven by many independent events, including:

1. The probability of aisle downtime
2. The probability of downtime lasting a significant period of time (thereby affecting operation)
3. The probability that inventory is only available in one aisle
4. The probability that, if inventory is only available in one aisle, it is in the aisle that is inoperable
5. The probability that this inventory is needed to fill an order during the period of downtime.



Captive Aisle System

Item 1: Probability of Aisle Downtime

Reliability and uptime for captive Storage/Retrieval Machines (SRM) are very high. Industry standards and historical benchmarks show minimum uptime of 98%. For purpose of evaluation, the probability of aisle downtime can be designed at **2%**.

Item 2: Probability that Aisle Downtime is Significant

Any downtime lasting longer than 20 minutes is considered significant in that it may impact shipping. The vast majority of SRM errors can be classified as nuisance type faults which are quickly recovered (such as load misalign and other sensor related errors). Per historical reporting, less than **10%** of total SRM downtime is related to errors lasting longer than 20 minutes.

Item 3: Probability that Inventory is Only Available in One Aisle

ASRS control systems actively distribute inventory across multiple aisles for availability. There are times, however, when the entire storage system holds only one pallet of inventory for a number of SKU’s. While this parameter is very operation specific it is a good estimate that, at any given time, **10%** of items on hand are reduced to a single pallet of inventory.

Item 4: Probability of Inventory Being in the Aisle that is Inoperable

Assuming that inventory has been reduced to one pallet, and is therefore in a single aisle, what is the probability that the inventory happens to be in the aisle that is inoperable? This parameter is wholly dependent on the proposed solution and number of aisles. Assuming a 5-aisle ASRS, the probability is 1 in 5, or **20%**.

Item 5: Probability of Single Pallet Inventory Being Required During Period of SRM Downtime

If inventory has been reduced to one pallet, then it is likely a slow moving item. While this variable is operation specific, the 80/20 rule can provide a decent metric. Assuming a slow moving item is part of the 20% of volume, it would be very generous to assume a **20%** chance of needing that inventory during the period of SRM downtime.

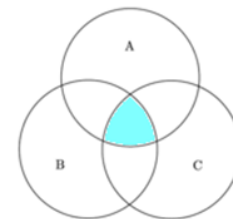
Probability Formula

The following formula applies to independent event probability:

$$P(A \text{ and } B \text{ and } C \text{ and } D \text{ and } E) = P(A) \cdot P(B) \cdot P(C) \cdot P(D) \cdot P(E)$$

Applying the examples used in items 1 through 5, the probability of not being able to access inventory in a captive aisle system is:

$$2\% \cdot 10\% \cdot 10\% \cdot 20\% \cdot 20\% = 0.0008\% \text{ (or 1 in 125,000)}$$



Independent Event Probability