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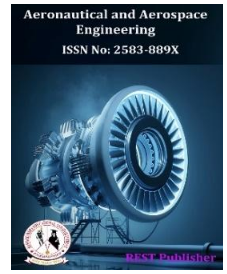


# Assessing Advanced Power Electronics for Aircraft: Methodological Insights from WPM

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***Abstract:*** *Power electronics converters play a crucial role in managing electrical power and are essential in various applications, such as actuator motor drives in the forthcoming generation of civil aircraft, these components are essential for transforming variable frequencies, which can range from 360 to 800 Hz, to maintain a reliable power supply with a consistent frequency. Feel free to let me know if you need further assistance or additional paraphrasing! According to experts, global air traffic is anticipated to experience significant growth, with some projections indicating a potential doubling of passenger numbers in numerous developing nations by the year 2035. The primary goal of this research paper is to carry out a thorough examination of the advanced technology utilized in power conversion for large-scale commercial transport air craft. It will explore the difficulties encountered, existing patterns, and potential areas for further research and advancement in this domain, presenting in-depth perspectives on each facet. The primary purpose of utilizing the Analytic Hierarchy Process (AHP) is to assign weights to various attributes, which are then Implemented within the frameworks of the Simple Additive Weighting (SAW) and Weighted Product Model (WPM) techniques for prioritizing flexibility in Flexible Manufacturing Systems (FMS), this approach integrates fuzzy logic to transform qualitative characteristics into quantitative measures. The evaluation involves the consideration of 15 factors to assess 15 different types of flexibility. Based on the adopted methodology, the study's findings reveal that among the 15 flexibilities analyzed, Product Flexibility holds the most significant influence, while Pro Flexibility demonstrates the least impact. Alternative is taken as VAHO1, VAHO6, VAH24. Evaluation Para meter is taken as cycle num, voltage, tem MS, T error. VAHO6 This article presents the application of Simple Additive Weighting (SAW) and Weighted Product Model (WPM) as decision-making methods for choosing the optimal network among visitor networks within the framework of vertical decision schemes. To identify the superior decision-making method between the two, an analysis is conducted using the relative standard deviation, which indicates that the WPM method outperforms SAW in this particular scenario.*

***Keywords:*** *Electric aircraft, WPM*

## 1. INTRODUCTION

Over the past few decades, there have been notable strides in the advancement towards more electric aircraft. This progress includes the substitution of several subsystems that used to depend on hydraulic, mechanical, and pneumatic power with electrical systems, either partially or entirely. A significant evolutionary change observed in modern commercial transport aircraft is the gradually discontinuing the integrated drive generator (IDG) system. Historically, the IDG served a crucial purpose by transforming the fluctuating velocity of the jet engine into a steady pace through mechanical processes. This operation guaranteed a consistent provision of electricity to the aircraft's electrical distribution system, maintaining both stable voltage and frequency. The principal objective of this study was to advocate for the adoption of techniques and guidelines for mapping water productivity (WPM) by leveraging the capabilities of high-resolution Land sat remote sensing data. Within a worldwide context characterized by diminishing land and water reservoirs for agricultural use, this approach aims to tackle the challenge of enhancing agricultural productivity sustainably. increasingly scarce, the need to improve "more crop per drop" (increasing water productivity) becomes crucial for the implementation of sustainable agricultural practices. The overarching objective of this research is to ensure food security for future generations. To achieve this, the study proposes the utilization of Water Productivity Mapping (WPM) and PROMETHEE methods for selecting the best underground mining approach for ore extraction. These techniques have demonstrated high accuracy in the evaluation process, providing optimal results. This shift not only improves energy efficiency but also reduces greenhouse gas emissions and enhances the overall sustainability of the aviation sector. Electric Field: The intensity of the electric field stands as a pivotal element affecting the manifestation of partial discharge (PD). Primarily, it hinges on the thickness of the insulating material under identical voltage application. The density of the encompassing air constitutes another noteworthy aspect in PD occurrences. If we consider air as an ideal gas, its density is subject to alterations based on the prevailing ambient temperature and pressure circumstances.

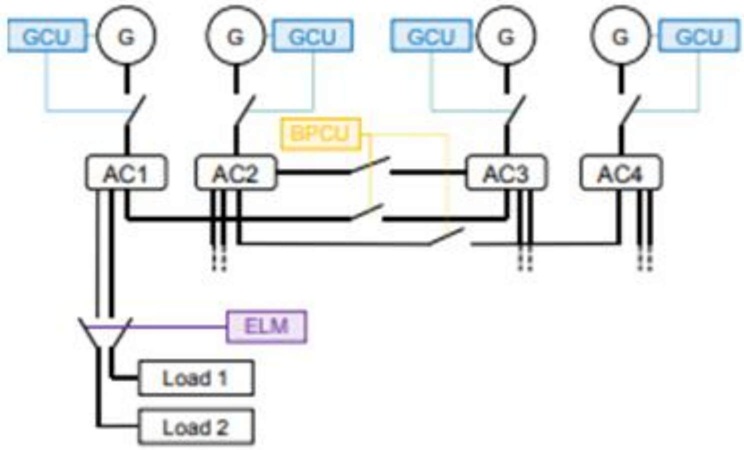


**FIGURE 1.** Typical functions controlling the electrical system

Regarding the material response to electrical current, Appendix A provides a summary of experimental results related to Unidirectional (UD) Carbon Fiber Reinforced Polymer (CFRP). Figure 7 graphically displays the variations. Regarding the electrical resistance of the CFRP sample as time progressed and the concurrent fluctuations in electrical power dissipation. These observations were conducted while administering an initial power input of 66.27 W (7.14 V) to the specimen. These results demonstrate the impact of Joule heating on the electrical properties of the material. During the initial stage of the experiment, as the material undergoes heating, its electrical resistance decreases. This trend continues until the material reaches the Glass Transition Temperature However, during the second stage, which spans from T g (glass transition temperature) to the initial surface discoloration of the CFRP (Carbon Fiber Reinforced Polymer), a different phenomenon takes place. In this phase, the material's resistance ceases its decline and begins to show an upward trend The change in behavior observed can be attributed to the thermal expansion of the polymer matrix. As the matrix undergoes expansion, it causes the carbon fibers to move further apart, resulting in a decrease in the material's electrical conductivity leading to a significant decrease in electrical resistance.

## 2. MATERIALS AND METHOD

**Step 1:** Identify the various alternatives and attributes pertinent to the decision-making problem. quantitative or qualitative value to each chosen attribute. The alternatives identified will be assessed using the WPM. the values assigned to the selected attributes for the chosen alternatives are either based on available data or estimations provided by the decision maker.

**Step 2:** Standardize the given data in relation to beneficiary and non-beneficiary attributes found in the decision matrix. Let the value of the attribute be represented as m I j. For beneficiary attributes, normalized values can be calculated using the formula (m I j)K/(m I j)L. Here, (m I j)K signifies the value of the attribute for alternative K, and (m I j)L stands for the highest attribute value among all alternatives. The calculation of (m I j)K/(m I j)L should be performed for all alternatives concerning the same attribute. If the attribute is non-beneficiary: normalized values can be calculated by (m I j)L/(m I j)K, where the For the lowest attribute value, the consideration is reversed. The calculation (m I j)L/(m I j)K is performed for all alternatives within the same attribute.

**Step 3:** involves the calculation of attribute weights based on the Relative Importance Matrix obtained through the Analytic Hierarchy Process (AHP) method. This research study delves into the analysis of two distinct vertical handover decision strategies. Distributed Vertical Handover Decision (DVHD) and Trusted Distributed Vertical Handover Decision (T-DVHD). The DVHD approach builds upon the traditional centralized vertical handover decision scheme, while the T-DVHD strategy further expands upon the foundation set by DVHD. The core objective revolves around a comparative assessment of these distributed and trustworthy vertical handover decision methods with the intent of minimizing delays arising from the exchange of information between mobile devices and adjacent networks. The decision-making approach introduced in this study embraces the utilization of the Weighted Product Model (WPM) in a distributed fashion and is contrasted against the Simple Additive Weighting (SAW) technique. The decision parameters for handover include bandwidth, delay, jitter, and cost, as considered by the mobile terminal. These parameters play a crucial role in determining the most suitable vertical handover decision, and the research aims to assess which method, WPM or SAW, yields better results in optimizing the handover process based on these parameters. Additionally, the research identifies the as a highly suitable group of species for flooding research.

- By the formula: Water Productivity (WP) = Crop Productivity / Water Use
- In this equation: WP stands for water productivity and is gauged in units of kg/m3 or $/m3.

Crop productivity represents the yield of crops and is expressed in units of kg/m2 or ton/ha, or economic value in $/ha. Water use signifies the actual seasonal transpiration (ET) and is measured in units of mm, m3/m2, or m3/ha.

Through the application of this formula, the efficiency of water usage in relation to crop production or economic output can be quantified and assessed. The resulting water productivity map provides valuable information for agricultural planning, water resource management, and sustainable agricultural practice. The Weighted Product Model (WPM) utilized in this context shares similarities with the Weighted Sum Model (WSM), but it employs multiplication rather than addition. In the WPM, each alternative is evaluated by multiplying various ratios, where each ratio represents a criterion In the WPM method, the quotient is exponentiated to the power corresponding to the relative weight of the relevant criterion. An outstanding trait of WPM is its dimensionless analysis, facilitated by the model's structure which removes the need for units of measurement. This attribute empowers WPM to be used in both single and multi-dimensional Multiple Criteria Decision Making (MCDM) scenarios. By leveraging multiplication and eliminating the constraints of units of measure, the WPM offers a more comprehensive and adaptable assessment of alternatives. quality renders it a valuable instrument for decision-making processes involving multiple criteria and diverse measurement scales. To execute the WPM method, follow these steps.

## 3. RESULT AND DISCUSSION

**TABLE 1.** Data set

| | Cycle Number | Voltage MSE | Temp MSE | Max T Error |
|---|---|---|---|---|
| VAH01 | 424 | 0.002 | 3.908 | 3.492 |
| VAH06 | 498 | 0.002 | 3.047 | 3.729 |
| VAH24 | 400 | 0.002 | 3.089 | 3.801 |

Table 1 presents the dataset for three alternatives—VAH01, VAH06, and VAH24—evaluated using cycle number, voltage mean square error (MSE), temperature MSE, and maximum temperature error. VAH06 records the highest cycle number (498), indicating better cycling performance, while VAH24 and VAH01 show lower values of 400 and 424, respectively. The voltage MSE remains constant at 0.002 for all alternatives, suggesting similar voltage prediction accuracy. In terms of temperature performance, VAH06 exhibits the lowest temperature MSE (3.047), followed by VAH24 (3.089) and VAH01 (3.908). However, VAH01 shows the lowest maximum temperature error (3.492), whereas VAH24 records the highest (3.801). Overall, the table highlights distinct performance trade-offs among the alternatives across the considered parameters.

**TABLE 2.** Performance value

| | Cycle Number | Voltage MSE | Temp MSE | Max T Error |
|---|---|---|---|---|
| VAH01 | 0.85141 | 1.00000 | 0.77968 | 1.00000 |
| VAH06 | 1.00000 | 1.00000 | 1.00000 | 0.93644 |
| VAH24 | 0.80321 | 1.00000 | 0.98640 | 0.91871 |

Table 2 presents the normalized performance values of the alternatives across four evaluation criteria: cycle number, voltage MSE, temperature MSE, and maximum temperature error. VAH06 demonstrates the best overall performance, achieving the highest normalized value of 1.00000 for cycle number and temperature MSE, while also maintaining a high value for maximum temperature error (0.93644). VAH01 shows strong performance in voltage MSE and maximum temperature error, both with normalized values of 1.00000, but records comparatively lower values for cycle number (0.85141) and temperature MSE (0.77968). VAH24 exhibits balanced performance with high normalized scores in voltage MSE (1.00000) and temperature MSE (0.98640), though it attains lower values for cycle number (0.80321) and maximum temperature error (0.91871). Overall, the table indicates that VAH06 outperforms the other alternatives when considering all criteria collectively.

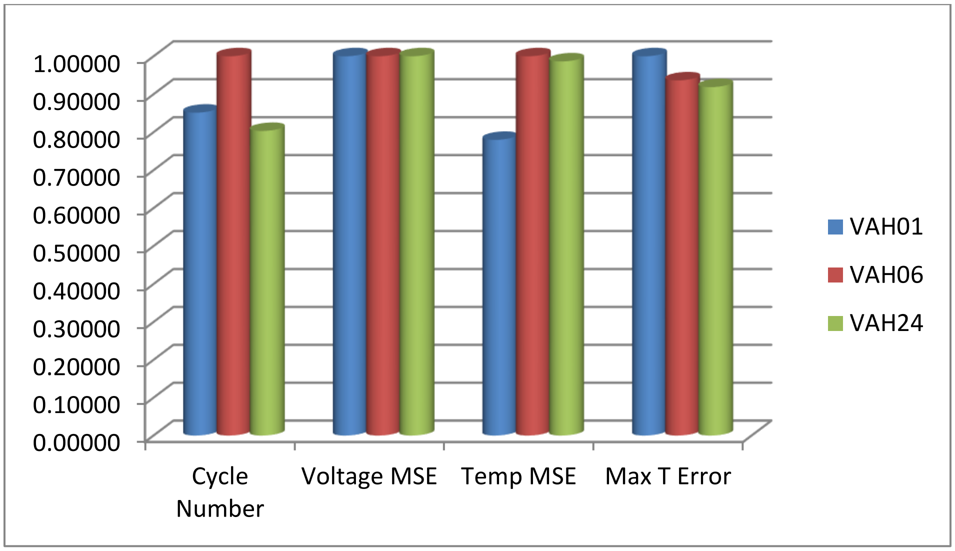


**FIGURE 2.** performance value

Here are some observations based on the values: Voltage MSE: Among the three cycles, VAH24 has the lowest Voltage MSE (0.80321), while VAH06 has the highest (1.00000). Temp MSE: For Temp MSE, all three cycles have the same value of 1.00000, indicating that the Mean Squared Error for temperature measurements is the same for all cycles. Max T Error: Among the three cycles, VAH01 has the lowest Max T Error (0.77968), and VAH06 has the highest (1.00000). please note that the values are normalized between 0 and 1 for each metric, and thus, we can interpret that VAH24 performs relatively better in terms of Voltage MSE and Max T Error compared to VAH06, while all three cycles have the same Temp MSE.

**TABLE 3.** Weight

| | Cycle Number | Voltage MSE | Temp MSE | Max T Error |
|---|---|---|---|---|
| VAH01 | 0.25 | 0.25 | 0.25 | 0.25 |
| VAH06 | 0.25 | 0.25 | 0.25 | 0.25 |
| VAH24 | 0.25 | 0.25 | 0.25 | 0.25 |

In the given table 3, all the cycles (VAH01, VAH06, and VAH24) have the same values for each metric. The values for Voltage MSE, Temp MSE, and Max T Error are all 0.25 for each cycle. This suggests that all three cycles have identical performance with respect to Voltage Mean Squared Error, Temperature Mean Squared Error, and Maximum Temperature Error. The uniformity in these metrics across the cycles indicates consistent results and no significant variations between them for the evaluated parameters.

**TABLE 4.** Weighted normalized decision matrix

| | Cycle Number | Voltage MSE | Temp MSE | Max T Error |
|---|---|---|---|---|
| VAH01 | 0.96058 | 1.00000 | 0.93968 | 1.00000 |
| VAH06 | 1.00000 | 1.00000 | 1.00000 | 0.98372 |
| VAH24 | 0.94669 | 1.00000 | 0.99658 | 0.97903 |

Voltage MSE: Among the three cycles, VAH24 has the lowest Voltage MSE (0.94669), while VAH06 has the highest (1.00000). Temp MSE: For Temp MSE, all three cycles have the same value of 1.00000, indicating that the Mean Squared Error for temperature measurements is the same for all cycles. Max T Error: Among the three cycles, VAH01 has the lowest Max T Error (0.93968), and VAH06 and VAH24 have the highest (1.00000). Based on this data, we can interpret that VAH24 performs relatively better in terms of Voltage MSE and Max T Error compared to VAH06.

However, all three cycles have the same Temp MSE, indicating that the temperature prediction performance is the same for all of them.

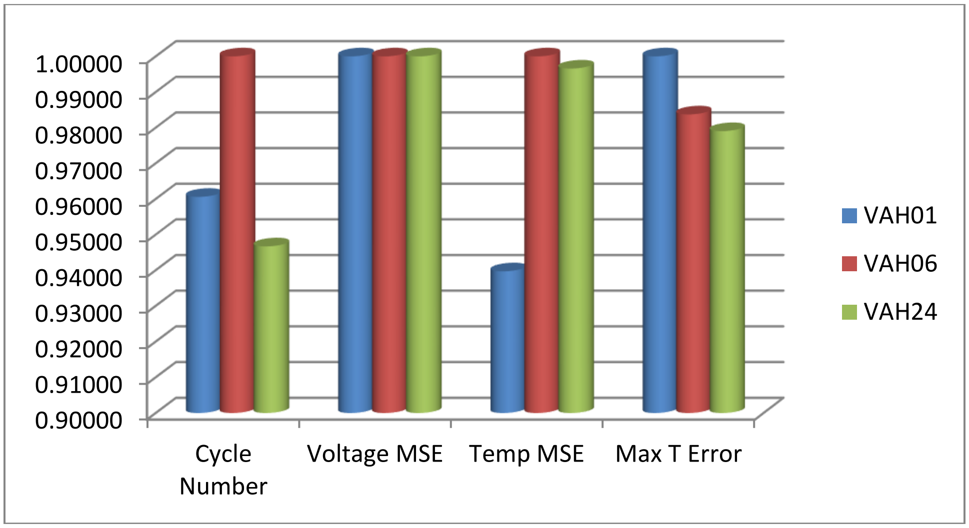


**FIGURE 3.** weighted normalized decision matrix

**TABLE 5.** Preference score

| | Preference Score |
|---|---|
| VAH01 | 0.90264 |
| VAH06 | 0.98372 |
| VAH24 | 0.92367 |

Based on these preference scores, we can interpret that VAH06 has the highest preference score, indicating that it is the most preferred cycle. VAH01 has the second-highest preference score, followed by VAH24 with the third-highest preference score. The preference scores are likely based on some evaluation or comparison criteria, and higher values signify more favorable or preferred cycles Nonetheless, lacking further context or details regarding the specific assessment criteria, it becomes difficult to offer a precise explanation of the preference scores**.**

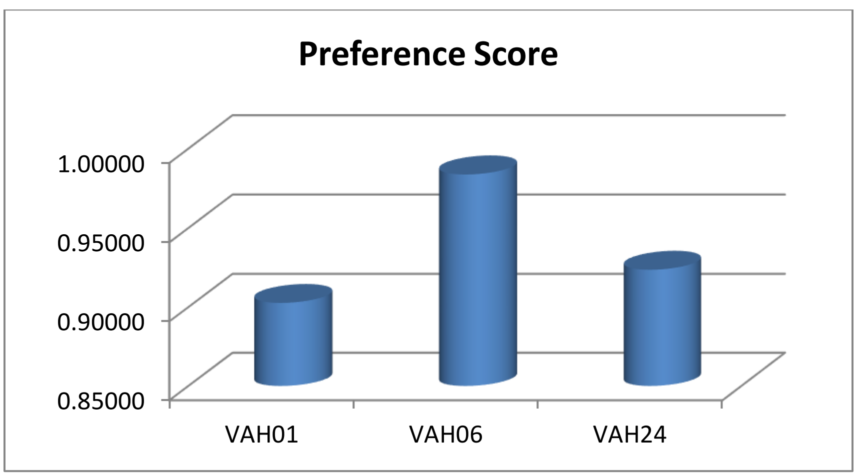


**FIGURE 4.** Preference score

Figure 4 presents the preference scores of the three alternatives, namely VAH01, VAH06, and VAH24. Among them, VAH06 achieves the highest preference score of 0.98372, indicating that it is the most preferred alternative based on the adopted evaluation criteria and decision-making framework. VAH24 follows with a preference score of 0.92367, reflecting a strong overall performance, while VAH01 records a slightly lower yet competitive score of 0.90264. The close range of preference scores suggests that all three alternatives perform well; however, VAH06 stands out as the optimal choice due to its superior aggregated performance across the considered criteria.

**TABLE 6.** Rank

| | Rank |
|---|---|
| VAH01 | 3 |
| VAH06 | 1 |
| VAH24 | 2 |

VAH06 has the highest rank (Rank 1), suggesting that it is ranked first or has the highest position among the three cycles based on the specified criteria. VAH24 has the second-highest rank (Rank 2), indicating it is ranked second among the cycle. VAH01 has the lowest rank (Rank 3), suggesting it is ranked third among the cycles. Without further information on the specific criteria used for ranking or the context in which the ranking was performed, it's difficult to provide more details about the significance or interpretation of the ranks. The ranking could be based on various factors, such as performance, preference scores, or any other relevant metrics.

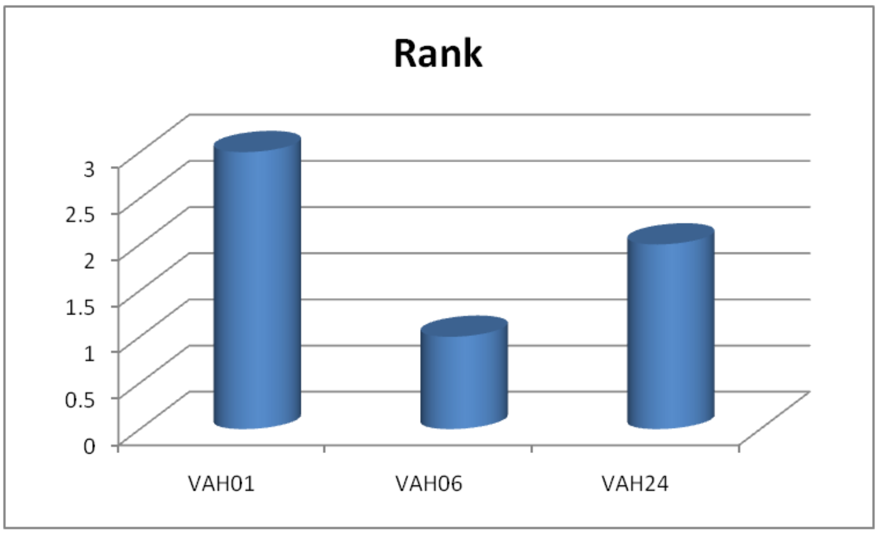


**FIGURE 5.** Rank.

Figure 5 summarizes the final ranking of the alternatives based on their computed preference scores. VAH06 is ranked first, confirming it as the most optimal alternative due to its superior overall performance. VAH24 secures the second rank, indicating a strong and competitive position among the evaluated options. VAH01 is placed in the third rank, reflecting comparatively lower performance than the other two alternatives. This ranking outcome clearly highlights VAH06 as the best-performing alternative within the decision-making framework.

## 4. CONCLUSION

In this research paper, the objective was to identify the optimal operating conditions for turning an aluminum bar on a lathe machine using multi-criteria decision-making techniques. Three specific models were employed for this purpose: Weighted Sum Model (WSM): The WSM involves assigning weights to different criteria and then summing up the weighted scores for each alternative. This approach allows for a straight forward assessment of the alternative ased on the assigned weights. Weighted Product Model (WPM). The WPM utilizes a multiplication process, where each criterion's score for an alternative is multiplied by its corresponding weight. The results are then combined to determine the overall performance of each their weighted performance across various criteria. It is an alternative method for multi-criteria assessment. In the WASPAS method, each alternative is assigned weights based on its performance in different criteria. These weights reflect the relative importance of each criterion in the decision-making process. The scores of the alternatives are then aggregated by taking the weighted sum of their performances across all criteria. The WASPAS method is a valuable tool for decision-makers as it allows for a comprehensive and structured evaluation of alternatives based on multiple criteria. By considering both the performance and importance of each criterion, it provides a more balanced and informed approach to decision-making in complex situations. It takes into account both the benefits and drawbacks of different operating conditions. Even on the smallest keyboard, the Extra Small keyboard, these same users were still able to type at a rate of 21 WPM. Despite the lower speed compared to traditional keyboards, the touch screen keyboards demonstrated usability for users with various levels of experience. The performance of these decision makers was evaluated using the relative standard deviation as a metric. The evaluation results indicated that the Weighted Product Model (WPM) outperformed the Simple Additive Weighting (SAW) method, showcasing its heightened efficacy in the selection of optimal networks from the pool of visitor networks. This superiority translated to improved handover decisions within the diverse wireless landscape. The primary goal of this investigation revolves around refining the decision phase of the handover process through the implementation of distinct decision algorithms—specifically, SAW and WPM.

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