

# IMPROVED POWER QUALITY ISSUES BY OPTIMIZE FUZZY RULES USING GREY WOLF OPTIMIZATION ON UPFC

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**ABSTRACT** - Power quality is a set of parameters that describes the process of providing electrical power to the user under normal conditions. It determines the continuity of the power supply and characterizes the power supply. When the voltage and current deviates from its normal values, it is called as event. These events occurred because of improper wiring or grounding and unbalanced loads. proposed fuzzy with PSO controller is better than the existing approaches in minimizing the sag and harmonic distortion. The whole process is enabling by using fuzzy membership functions and optimize by swarm optimization algorithm. The main aim of using the swarm algorithm is to minimize the voltage imbalance and harmonic distortion. The reactive power and negative-sequence current parameters will be considered in the near future.

**Keywords-** POWER, QUALITY, OPTIMIZATIO, PSO

## I. INTRODUCTION

Distributed Generation (DG) is predicted to play an important role in the electric power system in near future. It is widely accepted that photo voltaic generation is currently attracting attention to meet users' need in the distributed generation market. In order to investigate the ability of photo voltaic (PV) units in distribution systems, their efficient modelling is required. Distributed generation technology is a new, promising way of energy utilization. Where solar power is competitive to stand out from a variety of distributed power and become more developed relatively [1]. The control of grid-connected photovoltaic power generation system is a comprehensive process, which involves not only the technology about solar cell and grid-connected inverter, but also to the control and optimization problems of the system. In the end of the distribution network, the impact on power quality caused by the reactive load in the end of distribution network is more serious than which in centre grids. The fluctuations of reactive load will have a great impact on the supply voltage of power system, there by affecting other loads on this node [8]. The regulation of the PCC (Point of Common Coupling) voltage achieved by the PV system control scheme has a positive impact and important significance for the application of PV. The main circuit topology of three-phase active reactive power compensation device and three-phase grid-connected

inverter is exactly the same. Thus, in support of a reasonable control strategy it can be integrated together with both function of grid connection and reactive power compensation control [4]. When it output from photovoltaic cells, the inverter transforms DC into AC current delivered to the power grid, while selectively supply a certain reactive current compensation. When the reactive load fluctuates, the reactive component of the output current can be adjusted to achieve reactive power compensation by the control of PV grid-connected inverter, thus reduce the reactive power provided by large power grids through the transmission line. By reducing the reactive power flow in the grid, it can reduce the energy loss in transmission lines and transformers caused by reactive power transmission. Since the voltage of grid-connected PV system mainly depends on the support of large power grid, when the reactive load fluctuates, a stable system voltage can be achieved by maintaining a constant reactive power output of large power grids [12] [24].

The solar based DG units plays an increasing role in power system of near future. The development of power electronics technology plays a key role in the integration of DG units which change the vertical power system to a horizontal one. DGs can be designed to provide ancillary services to the utility such as reactive power support, load balancing, voltage support, and harmonic mitigation.

Power quality is a very important issue in distribution system. Power quality is simply defined as a quality of electricity i.e. it is a concept that is use to describe the purity of the transferred energy. As per IEEE Std. 1100 Power quality is defined as concept of powering and grounding sensitive equipment in a manner that it is suitable for the satisfactory operation of that equipment. But, the power quality is disturbed or destroyed due to several problems occurring in the electrical network for e.g. voltage sag, Voltage swell, unbalance of voltage and current, harmonics produced in voltage and current flickers transient over voltage supply interruption etc. The allowable source voltage and load current distortion or THD limit as per IEEE standards must be strictly maintained.

## II. RELATED WORK

**Renukadevi V, et.al [13]** represented a strategy based on synchronous reference frame and a grid associated PVG i.e. photovoltaic generation system that sends active power to grid, absorbing the reactive power and compensating harmonics generated by the local loads. The models of converter controller were put into action using MATLAB/SIMULINK. Implemented PV model performance was studied related to isolated load. The strategy of synchronous reference frame was used for generating current reference for the process of compensation and traditional PI controllers were used for controlling purpose. The approach helps in utilizing co-ordinate transformations for separation of the harmonic and reactive content present in load current.

**Panduri Renukeshwar, et.al [14]** presented a grid (multi-functional) interactive PV system using the concept of fuzzy logic on the basis of MPPT. The proposed controller of MPPT was able to check and track the accurate form of MPP under rapidly changing and uniformly varying insolation and it provides fast process of convergence in terms of a variable step size in case of duty ratio when it was applied genetically with the help of algorithm. The fuzzy controller proposed maintains the voltage-based dc link within a specified limit for injection of power into grid system. Injection of active power during the interval of daytime, the PV-based inverter also helps in compensating the reactive power and harmonics during the day as well as the night time. The current i.e. drawn from grid system was of sinusoidal form and the harmonic distortion in total was below the specified limit in IEEE-519 standard.

**M.T.L.Gayatri, et.al [15]** presented a review of distinct methods of compensating the reactive power in microgrid on the basis of control algorithms, devices, and methods. Several techniques were proposed for traditional grids and these techniques/approaches were adopted for compensation of reactive power in micro grid structures, progressively improved devices and methods were suggested and applied further. Among these devices, the growth in FACTS i.e. Flexible AC Transmission Systems was possibly meant for providing the compensation of reactive power in micro grids on dynamic basis. Finally, this paper represents various applications and techniques of FACTS devices for compensation of reactive power in microgrids.

**Ankita Gaur, et.al [16]** attempted to perform the evaluation of opaque and semi-transparent PV modules of distinct solar cell generation, reporting maximum efficiency in the section of literature at STC (Standard Test Conditions). This study was based particularly for the months of January and June. For commercially available opaque and semi-transparent modules of PV, outdoor-based performance was also evaluated. Annual

capitalized cost, electrical energy, cost per unit electrical energy, and uniform cost, for both solar modules types, namely, opaque and semi-transparent have been computed including characteristically build curves. PV module based on semi-transparent methodology have shown greater efficiencies as compared to opaque methodology.

**Hao Wu, et.al [17]** briefly explained the present development trends of implementing photovoltaics (PV) on the basis of status linked with electricity supply and energy distribution characteristics in China. The technology of PV, particularly the applications of grid-associated photovoltaic system was discussed. Finally, future suggestions and challenges for PV industry were presented and analyzed.

**Bin Li, et.al [18]** presented a control based on grid-connection on the basis of a PV system model with paralleled load in the (large) system. It makes full use of power associated with photovoltaic and it also maintained a stable form of voltage with reactive (fluctuant) load. It mainly adopted the control based on double-loop methodology. The current of large system and the current associated with grid of the PV system both were decoupled into reactive and active component by using a transformer of abc/dq0 type. In case of PV grid-connected current, the active component of the system was adjusted to a reference value provided by MPPT (Maximum Power Point Tracking) for maintaining maximum form of active power PV output. Whereas, in case of large system current, reactive component was adjusted for maintaining a uniform output based on reactive power. It helps in maintain a stabilized voltage with fluctuant load, as the grid-PV system supply voltage was sustained mainly by large system.

**Mohamed A. Eltawil, et.al [19]** investigated and emphasized the significance of grid-associated PV system in regard to the renewable generation intermittent nature, and the PV generation characterization in regard with grid code agreement. The inspection was mainly conducted to review the literature based on the expected potential issues linked with high levels of penetration and the methods of islanding prevention in connection to grid connected PV. In this survey, the grid connected PV inverters have performed fairly well. For large operational range, the power factor and conversion efficiency exceed 90%, while THD obtained was less than 5%.

**Hyo-Ryong Seo, et.al [20]** dealt with methods of reactive power and harmonics compensation by using grid associated Photovoltaic system. The experiment was carried on a proposed grid-associated single-staged PV system, and the system was controlled using TMS320F2812, a digitally built signal processor. The results obtained from the experiment involve converter-based operating features either as STATCOM i.e. static synchronous compensator or as an active power filter, while the process of transfer of real power to the grid system.

The obtained results help in validating the reliability of the proposed approach.

**Milan Prodanovic, et.al [21]** examined various methods of control emphasizing either local-voltage distortion or harmonic-line flows, or a compromising approach on the basis of resistance emulation was shown to be of effective nature. The experimental results based on 2 kVA inverter and 1 $\Phi$  laboratory-based network were used for illustrating the additionally built control functions that can be integrated into a scheme of existing control for the management of real-power. The observers of Kalman were used for achieving an additional benefit of bypassing specific phase-locking mechanism while generating quadrature components that was useful in providing feed-forward compensation and in calculating reactive power instantaneously.

**Marcelo Cavalcanti, et.al [22]** presented a system providing PV generation and the functions of a UPQC i.e. unified power quality conditioner. Such a system can be used for controlling for harmonics and provide compensation of reactive power on simultaneous basis using an operating form of converter as an active shunt filter. The other form of converter was mainly used as active series filter which helps in compensating the voltage sags or voltage harmonics and swells of the system. The only use of inverter in the process of PV energy conversion, presented an increased form of efficiency as compared to the traditional systems. The method of SRF i.e. synchronous reference frame was used in controlling 3- $\Phi$  converters of the system. The simulation results have demonstrated good performance of the configuration that was proposed

### III. THE PROPOSED METHOD

#### 3.1 Proposed Methodology

Particle swarm optimization (PSO) algorithm is essentially a system based on agents which simulate the natural behavior of ants, including mechanisms of cooperation and adaptation. It is designed to reproduce the ability of Particle to determine the shortest paths to food. Real ants can indirectly communicate by pheromone information without using visual cues and are capable of finding the shortest path between food sources and their nests. The particle finds local and global optimize rules on the trail while walking, and the other ants follow the (i) each path followed by an ant is associated with a candidate solution for a given problem. (ii) When a particle follows a path, the amount of local deposited on that path is proportional to the quality of the corresponding candidate solution for the target problem. (iii) When a particle has to choose between two or more paths, the path(s) with a larger amount of particle have a greater probability of being chosen by the optimization. This algorithm is most simple and involves only a few steps for finding challenging solutions even in complex domain. PSO is

used to find the fuzzy membership functions for the control of UPQC.

#### 4.4 Algorithm Used

In this section the algorithms are explained in detail. In the proposed work we use fuzzy logic with PSO, ACO and only fuzzy logic. The below given section contains Fuzzy logic, Particle swarm optimization and Ant colony optimization. The PSO and ACO algorithms are bio-inspired algorithm and solve the meta-heuristic problems. These algorithms work effectively when they hybrid with fuzzy rules and gives better outcomes.

##### 4.4.1 Fuzzy Logic

The word fuzzy represents the thing which is not clear. In the daily life we encounter some situation in which we can't determine the true or false state but the fuzzy logic provides a way and a flexible reasoning. The computer system depends on the binary approach in which 0 represents the false and 1 represents the true but in the fuzzy logic there is also a logic for partially and partially false condition.

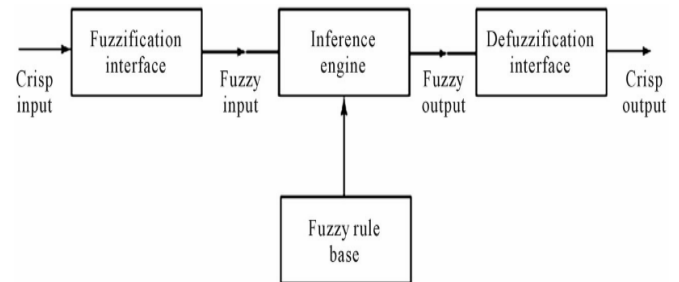


Figure 4.3 Fuzzy Logic Architecture

**Fuzzification:** This system converts the crisp input into fuzzy sets and then this input is sent to inference engine.

**Inference Engine:** It is used for matching degree for the crisp input and then rule according to input field.

**Defuzzification:** It changes the fuzzy set from the inference engine into the crisp value for output.

#### 4.5 Simulation Environment

The proposed work is done on the MATLAB in which we can use Simulink for performing the proposed experiment. Simulink is basically an environment which draws block diagrams for model-based design. In Simulink it is possible to design, simulation and automatic code generation and also doing verifications of the embedded systems. It is basically a graphical editor which contains customizable libraries.

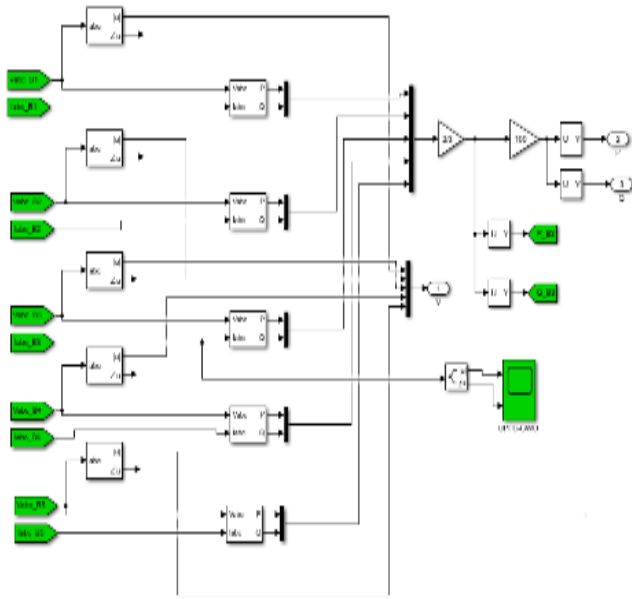


Figure 4.4 Simulink Environment for Proposed work UPFC-GWO.

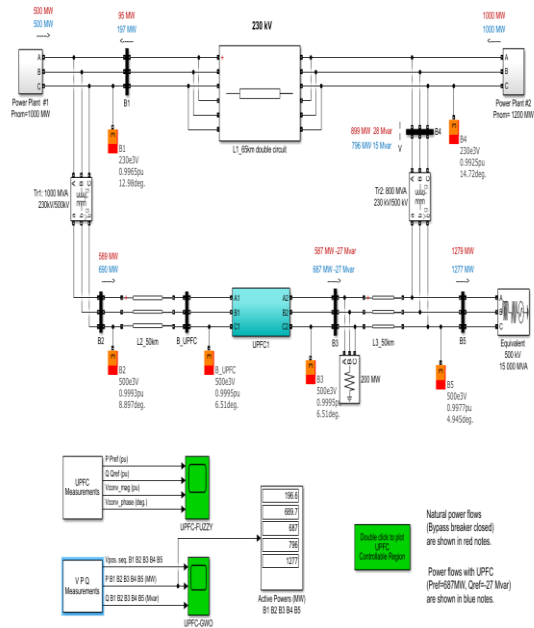


Figure 4.5 combined UPFC\_GWO AND UPFC\_FUZZY.

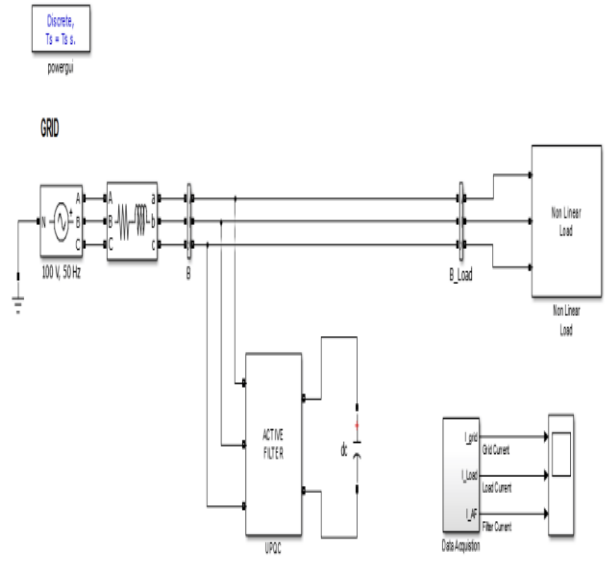


Figure 4.7 Circuits Drawn by Simulink non-linear load

#### IV. RESULT ANALYSIS

- 4 Magnitude
- Voltage

#### 5.3 Results

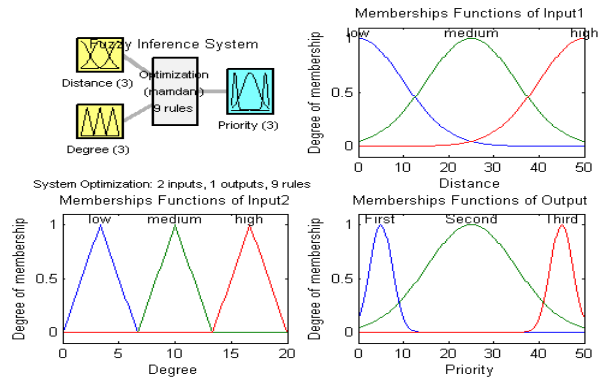


Figure 5.1 Fuzzy Inference System outputs

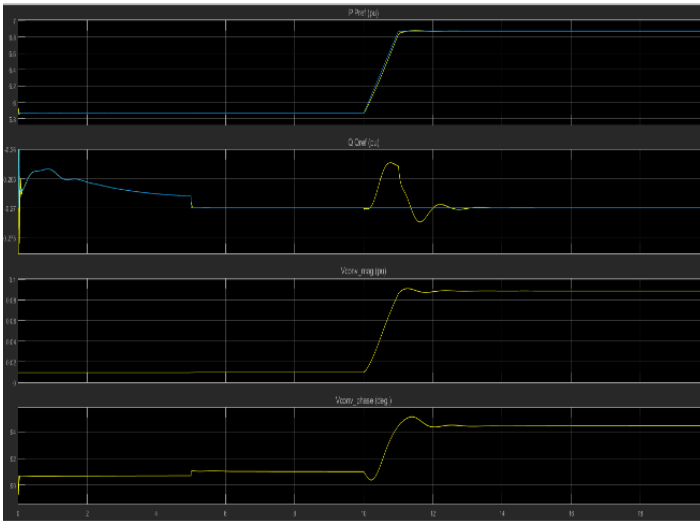


Figure 5.2 Fuzzy Inference System and GWO voltage magnitude outputs

In figure 5.1 the input of the fuzzy inference system is presented by using graphical method. The membership function of input 2 and output of this input is presented in this figure. The blue line represents the low degree of membership, green represented medium degree and red represents the high degree of the membership function.

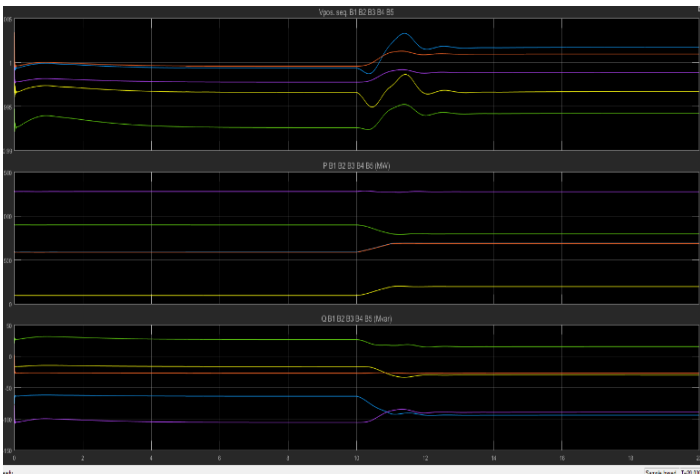


Figure 5.3 Fuzzy Inference System and GWO Power magnitude outputs

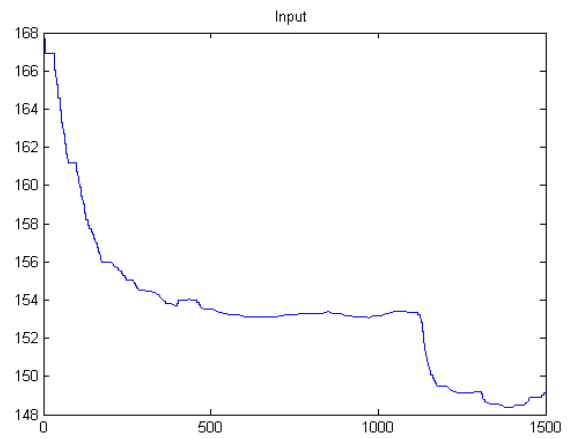


Figure 5.4 Non-linear Input of the fuzzy method.

The above given figure 5.2 shows the non-linear input of the fuzzy method. This curve input shows the quality and iteration.

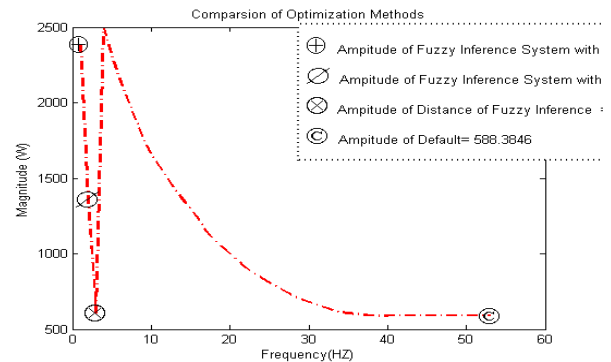


Figure 5.5 Comparison of Optimization models

The figure 5.3 presented the comparison between the amplitude of Fuzzy inference system with PSO, Fuzzy inference system with ACO and only fuzzy system. The graph is drawn between frequency and magnitude of the different algorithms. The graphical representation shows the effective results of the Fuzzy inference system with PSO among three algorithms.

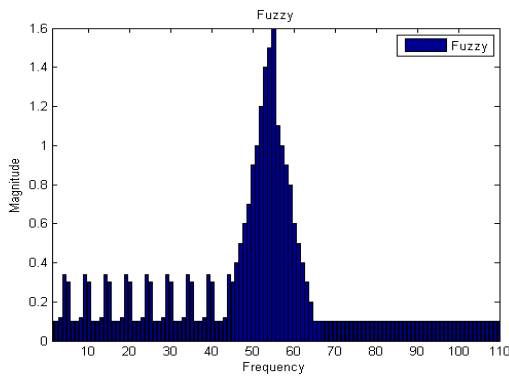


Figure 5.6 Output of the Fuzzy algorithm

The figure 5.4 presents the output of the fuzzy algorithm. The X-axis of the graph show frequency and Y-axis show magnitude values. The Fuzzy value on the frequency 50-60 is higher and the value is stable from 60-110 frequency.

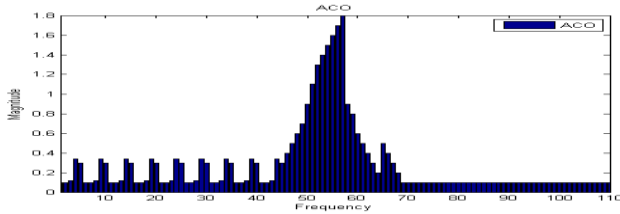


Figure 5.7 Output of the ACO with Fuzzy algorithm

The figure 5.5 presents the output of the fuzzy algorithm. The X-axis of the graph show frequency and Y-axis show magnitude values. The Fuzzy value on the frequency 45-70 is higher and the value is stable from 70-110 frequency.

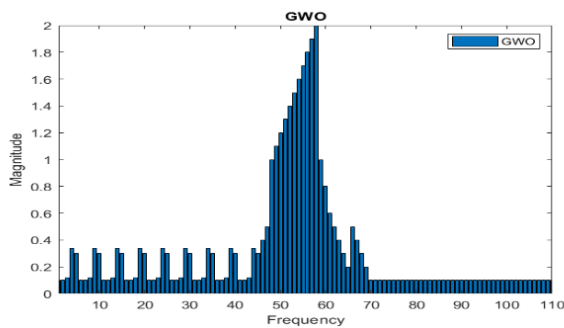


Figure 5.8 Output of the GWO with Fuzzy algorithm

The figure 5.6 presents the output of the fuzzy algorithm. The X-axis of the graph show frequency and Y-axis show magnitude values. The Fuzzy value on the frequency 45-70 is higher and the value is stable from 70-110 frequency.

### V CONCLUSION

To enhance the quality of power has becomes an effective area of research in power system and power electronics. The conditioners are required in the power systems due to high frequency switching and non-linear loads. Unified Power Quality Conditioner (UPQC) is an electronic device which solves the problem of voltage sag and total harmonics distortion problems. The conditioner is a combination of series active and shunt active power filters. The power quality is enhanced by integrating the power filters. The proposed work is done by using fuzzy logic with swarm intelligence approach and proposes a new UPQC system. This system reduces the sag and harmonic distortion. The PSO is used to optimize the reference signal which is generated by the fuzzy logic controller. The proposed experiment is done on the MATLAB/ Simulink environment. The results and output received on this is used for the analysis. The proposed fuzzy with PSO controller is better than the existing approaches in minimizing the sag and harmonic distortion. The whole process is enabling by using fuzzy membership functions and optimize by swarm optimization algorithm. The main aim of using the swarm algorithm is to minimize the voltage imbalance and harmonic distortion. The reactive power and negative-sequence current parameters will be considered in the near future.

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