Response to second report of Referee A

There are fundamental misunderstandings in the referee's report: I reproduce his/her statements in italics (emphasis added).

"*The partial result derived by the author and considered by the author to be the central point, namely the entropy generated by dissipative normal fluid currents,* ***does not prove that the final state is not an equilibrium state***"
I never said that the final state is not an equilibrium state. I am considering the final state after the system has reached equilibrium, and it is of course an equilibrium state.

"*The thermal reservoir is by definition a system that can absorb an arbitrary amount of heat from the system under consideration, which implies that it is infinitely larger.*"

"*The problem with this argument is that the system and the reservoir are both considered as closed finite systems. But* ***the reservoir is an open system, or equivalent, an infinite system.*** *If it were not so, the entropies of both systems would decrease in the cooling process, in contradiction with the second law.*"

The referee's argument is incorrect. The reservoir is not "an open system", and it is not "infinitely large". Following common practice, I assume the "reservoir" is substantially larger than the system only for simplicity, so I don't have to worry about how much its temperature changes. But there is no reason to do that. The system starts at temperature T_1, the "reservoir" starts at temperature $T_2<T_1$, when they have reached thermal equilibrium they will both attain temperature T_3, with $T_2<T_3<T_1$. If the "reservoir" is large, T_3 will be very close to T_2, if not it will not, but it doesn't matter. The key point is that the value of T_3 cannot depend on whether Joule heat was generated or not, by conservation of energy.

Let me prove the last statement in case it's not obvious. Energy is a function of state. So the energy of the system at temperatures T_1 and T_3 are fixed, so are the energies of the "reservoir" at temperatures T_2 and T_3. The "system plus "reservoir"" is the universe, there is nothing else. So by conservation of energy

$$E_{sys}(T_1)+E_{res}(T_2)= E_{sys}(T_3)+E_{res}(T_3) \qquad (1)$$

If, by having the process go at different speed, with different Joule heat generated, the system plus reservoir would attain an equilibrium temperature T_4, we would have by conservation of energy

$$E_{sys}(T_1)+E_{res}(T_2)= E_{sys}(T_4)+E_{res}(T_4) \qquad (2)$$

Therefore combining (1) and (2),

$$E_{sys}(T_3)+E_{res}(T_3)= E_{sys}(T_4)+E_{res}(T_4) \qquad (3)$$

hence from (3)

$$E_{sys}(T_3)- E_{sys}(T_4)= E_{res}(T_4)- E_{res}(T_3)$$

The last equation implies that if $T_3>T_4$ the reservoir has a negative heat capacity, and if $T_3<T_4$ the system has a negative heat capacity. Neither is possible, hence $T_3=T_4$.

Therefore, system plus 'reservoir' have to reach a unique final equilibrium temperature, independent of how much Joule heat is generated in the process. Therefore, the considerations in my paper apply, and the objection of the referee does not apply.

And specifically, the statement by the referee *"But the reservoir is an open system, or equivalent, an infinite system.* ***If it were not so, the entropies of both systems would decrease in the cooling process, in contradiction with the second law***." is of course incorrect. When we put two finite bodies at different temperature in contact, after they reach equilibrium the entropy of one has decreased, the entropy of the other one has increased, the entropy of the universe has increased, and there is of course no "contradiction with the second law".

In summary, the report of the referee is incorrect, and there is nothing in the report that would cast doubt on the statements and conclusions in my paper.