



2003 World Solar Challenge

Darwin > Adelaide 19 - 28 October 2003

RACE ANALYSIS

NUNA II POWERS TO NEW RACE RECORD OVER AURORA 101 31 December 2003

The seventh World Solar Challenge was won by the new solar car from the Dutch Nuon team, Nuna II, when it finished the 2003 event at 3.24 PM on the fourth day out of Darwin. The 3010 kilometre journey was completed in 30 hours, 54 minutes at an average speed of 97.02 km/h, a new event record.

Aurora 101, the top Australian entrant and competitor in all seven World Solar Challenge events since 1987, trailed the Dutch car into second place. It finished 1 hour 43 minutes behind Nuna II completing the distance in 32 hours 54 minutes at an average speed of 91.90 km/h [breaking the event record set in 2001].

Both Nuna II and Aurora 101 finished in 4 days, joining the 1996 Honda entry in this achievement. Along the way they and the third place finisher MIT's Tesseract reached Alice Springs in two days, a feat achieved previously only by Honda.

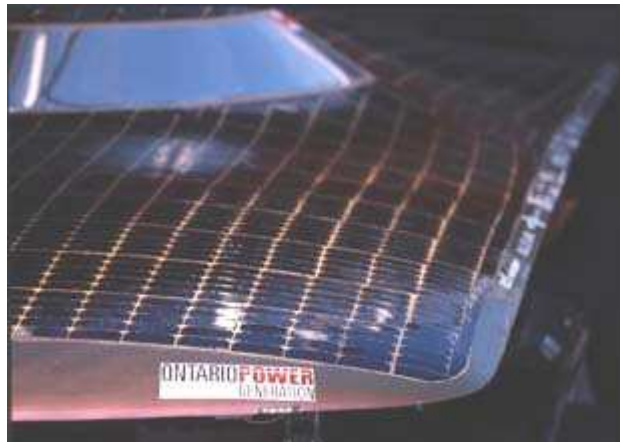
The 2003 WSC was the event for showing the power of the space industry's triple junction Gallium Arsenide solar cells with 4 solar cars achieving solar power in the 1900-2200 watt range. In the case of Nuna II, the most powerful car in the event, this had the effect of overshadowing the traditional need for extreme vehicle efficiency and for extreme watchfulness of the battery condition. Even Aurora 101 adopted some triple junction Gallium Arsenide solar cells over 40% of its solar array and relied on its total vehicle efficiency to stay close to the fantastic Nuna II car.

The achievement of a 97 km/h average speed by Nuna II suggest that the average of 100 km/h may be exceeded in the future although this is more difficult than it may seem.

THE ENTRIES

The entry list of traditional solar cars was the smallest in the event's history yet contained the fastest cars ever gathered for the World Solar Challenge. Twenty two cars were officially approved to start. They represented 10 countries. The entry level was affected by the poor global economic conditions of 2003 which limited the extent of sponsorship available for many teams. Also 2003 was the year for the major US event, the American Solar Challenge, which reduced some of the resources that were available to some US teams to double up for the WSC in the same year. Finally the prospect of a highly prestigious event in May 2004, the pre-Olympic Phaethon 2004 in Greece had an impact on the number of Japanese teams able to also participate in the 2003 WSC.

Nuna II, Queens' Gemini, Bochum's HansGo, and MIT's Tesseract all were equipped with triple junction Gallium Arsenide solar cells with efficiencies in the 25-27 % range.



The Canadian Gemini 2 seat solar car from Queens University



MIT's sleek 2 seater windshield



Checking out the new 'Hans Go' entry from Bochum University in Germany

Principia's Ra V solar car and Queens' Gemini had participated in the 2003 ASC finishing 4th and 6th respectively. They did a great job to be in Darwin less than 3 months later.

Two new cars were entered from Taiwan and an entry came from Malaysia showing a growing interest in this technology from Asia.

Finally everyone was interested in the return of the 'suitcase man' Detleff Schmidt from Munich, Germany with his Heliodet solar car in his seventh attempt to cross the Australian continent and to be counted amongst those that have finished the race.



Aurora 101 team member checking out the HelioDet solar car at the pits

PRE-RACE PREPARATIONS [AURORA 101]

The Aurora Vehicle Association had been upgrading their technology since early in 2003 with the aim of gaining a good shakedown in either the 2003 ASC or the main Japanese event, the 'Dream Cup' at Suzuka. The 'Dream Cup' was the more achievable and we had great encouragement from the famous Japanese newspaper the Yomiuri Shimbun to appear at Suzuka.

This event allowed the technology to be tried and settled. Along the way Aurora 101 won the second 4 hour heat and became the first solar car in the 12 year history of this event to travel 50 laps. Aurora 101 also recorded the two fastest race laps. As a result the technical preparations needed for the WSC were minimal.

Compared to the 2001 Aurora RMIT 101 solar car the main technology improvements incorporated in 2003 were:

- Power upgrade to 40% of solar panels through adoption of triple junction Gallium Arsenide solar cells
- Adoption of Lithium polymer battery system sourced from Kokam in place of lithium ion batteries
- A new motor controller system from Australian supplier Tritium
- A more substantial roll bar, a larger head bubble and a more rearward positioned driver seat
- A general weight reduction of 25-30 kg

The base for Aurora in Darwin was the TOLL truck and transport distribution centre. TOLL have graciously assisted Aurora on a number of occasions by safely and promptly transporting our support cars and trailers from Melbourne to Darwin and allowing us to use their Darwin workshop facilities. We thank Scott Chapman for trusting us in his premises and for the friendship of Ernie and Wendy who work there. A number of TOLL truck drivers helped us on the road with competitor reports on the two way radio and in difficult passing situations.

Our great fleet of 4 support cars from Ford were all complete before leaving Melbourne and looked extremely business-like. The two Falcon wagons were especially practical as support cars for their extra

carrying capacity and the full passenger carrying capability. Also the super efficient Orbital-engined Festiva from Orbital made a good runabout and scout car for the team.

Our remaining jobs in Darwin were:

- Balancing and cycling the battery packs. This is a long job and takes extreme care as the empty point is reached. As a precaution we did replace 2 blocks of battery cells which seemed uneven compared to the rest
- Setting the power point trackers to the revised battery voltage and matching to the new motor controller
- Resetting wheel alignments to get the lowest rolling resistance and balancing all the wheels
- Tape cleaning the solar array. This is a 10 person, hour-long job and is done infrequently. But we needed the cleanest and most effective solar array possible
- Finishing a new hard shell cover over the front suspension. This also required the assistance of a motor trimmer to make the sealing sleeves
- Making the 'Jolly' switch. This was a mechanical device which could be operated by the solar car driver to have the motor controller memorise a new phasing sequence if required when a front wheelmotor was changed. It was named after its inventor, team member Paul Jolly



Paul constructs the 'Jolly Switch' in Darwin



Aurora 101 driver Stella Ngondi passes road permit test



Nuna II chiefs Wubbo Ockels and Diedrich Kinds visit Aurora workshop to discuss tyre characteristics



Nuna members examine Aurora 101/CSIRO high efficiency wheelmotor

We needed to make a test run on the road in order to give our drivers fresh convoy procedure experience. This took place on Tuesday 14 October in a run to the town of Jabiru. For this we needed to travel 120 km from Darwin before putting the solar car on the road. This was a successful trip during which we saw Nuna II for the first time and caught up with some of Nuna's 12 person media crew. Also we had a fine visit to the Jabiru Area School in keeping with our program objective of spreading the message of renewable energy to as many schools as possible.

Given we had 5 support cars it required 2200 km of driving to achieve 200 km of solar car testing.



Bushfire prevention road-sign. A similar one is displayed in the Australian Museum, Canberra



Fascinated schoolies at Jabiru Area School

All other testing was conducted from the Hidden Valley racetrack where we had been allocated pit #1. At the track we were able to see and socialise with most of the other teams as well as practice for the qualifying session scheduled for Saturday 18 October.

Before that we went through scrutineering requiring only a small improvement to some of our wiring protection. Aurora 101 was the first car to go through scrutineering which occurred on Thursday 16 October. The surprise for us was how heavy Nuna II was. Some 67 kg heavier than Aurora 101 and a factor that would be of significance in the qualifying session, if not the race itself.

Because of our earlier preparations we were able to spare Dennis Thoroughgood and Peter Pudney to offer assistance to other teams who had a few problems left to solve.

The team needing the most help was the one from Puerto Rico with a car misnamed 'The Paradise'. It had been damaged in transit and sent to Australia unfinished. All week the team suffered setback after setback and even after qualifying had finished they were not approved to start. At the Northern Territory Cocktail Function hosted by Chief Minister Claire Martin, race director Chris Selwood triumphantly announced that 'The Paradise' had been approved to start.



Puerto Rico's team 'The Paradise' stops at the Aurora 101 pit for help. Gladly given.

A new tone of friendship was emerging amongst the teams helped by most of them using the track facility and by the accessibility of the Nuon team members. The Dutch were there in numbers with most of their 2001 winning team having come to support the new team for 2003.

Aurora had Nuon people visit the TOLL workshop a number of times and joined in a 'splashy' BBQ with Nuon. Splashy because most everybody got thrown into the pool.

Our new team 'Southern Aurora' arrived on Tuesday afternoon 14 October after their long drive from Hamilton Victoria. Exhausted. Facing time pressures to clear scrutineering and make sure their car was operational. They sported a fine new custom built trailer which Jack McArthur had committed to making and a dented sponsor car.



Southern Aurora unzips for scrutineering. All in 8 weeks

The bad news was from the University of New South Wales who rolled their tow vehicle and solar car trailer on the drive to Darwin. The solar car was badly damaged and they had to withdraw from the event.

Aurora team member Greg Heins, now located in Darwin came to see us, as did Stephen Bicknell our motor specialist. Stephen had made a special trip to Darwin to check out the competitors and their latest technology. Bill Bennett another Aurora team member from Melbourne was also in Darwin so we saw him at the track. His brother in law was in charge of the Thrifty rental vehicle business and was doing a big bit of business with the solar car community.



Ex Bosch and now Darwin based team member Greg Heins

One formality at scrutineering was the driver weigh-in. Also the drivers choosing not to wear crash helmets had to sign an indemnity for the organisers. All three Aurora drivers Tony Vriens, Stella Ngondi and Mark Gilligan chose not to wear helmets in order to retain better visibility and to keep cool.

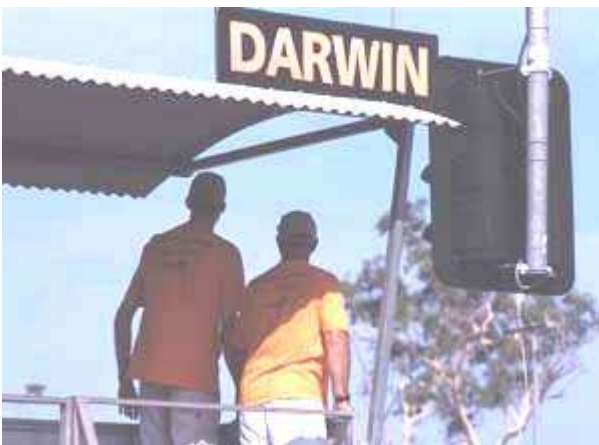
QUALIFYING, SATURDAY 18 OCTOBER

The organisers threw a big surprise when they announced a totally different qualifying procedure from previous events.

In the past qualifying was determined by the fastest speed achieved over approximately 400 metres on the straight of the Hidden Valley Racetrack. Whilst doing this run competitors would be passed by a road-train coming in the opposite direction in order to test stability. The fastest that Aurora had achieved was 101.9 km/h in 2001 good for 5th position.

For 2003 the procedure was to be timed laps around the entire race-track with no passing of a road-train. Whilst it was a surprise the Aurora team knew that Aurora 101 was a great all-round car and that we had done plenty of timed laps in Japan at the famous Suzuka Formula 1 track.

We selected Mark Gilligan as the driver for qualifying. He had raced Suzuka in 2002. On Friday afternoon we set him loose for practice and after a number of laps he came in with two worn out tyres and a best time of 2 minutes 20 seconds. Seemed OK.



Nuna II chiefs examining the Hidden Valley race-track in at qualifying



Nuna II sets off for its qualifying dash around Hidden Valley



Aurora 101 driver Stella Ngondi guards the solar car at Hidden Valley pit

The organisers planned to send qualifiers out in groups of 4. The first group contained Aurora 101 and Southern Aurora. Mark pulled his time down to 2 minutes 15 seconds. Bochum clocked 2 minutes 28.15 seconds and Southern Aurora a pretty good 2 minutes 34 seconds.

Now we were to sit and watch for the rest of qualifying offering cool drinks and fruit to other teams, waiting to see if anyone would beat our time. The Taiwan team Formosan surprised everybody at 2 minutes 23.34 seconds, and MIT hustled around at 2 minutes 24.92 seconds.

Finally we saw Queens and Nuon hit the track. We expected better. Both showed the disadvantage of having heavy cars and could do no better than 11th and 10th respectively. Nuna II achieved just 2 minutes 42.95 seconds or nearly half a minute behind Aurora 101.

By the end of qualifying Aurora 101 remained the fastest and would start at the head of the field on the following day; the first Australian team to do so in the history of the WSC. The top 15 positions were as follows:

1.	Aurora 101	2-15.40
2.	Formosan	2-23.34
3.	MIT	2-24.92
4.	Bochum	2-28.15
5.	Suria Kar 2	2-31.24
6.	Southern Aurora	2-34.00
7.	Houston	2-35.23
8.	Southern Taiwan	2-35.32
9.	AGU Japan	2-39.29
10.	Nuna 2	2-42.95
11.	Queens	2-43.27
12.	Principia	2-45.95
13.	Kormilda NT	2-53.92
14.	Kelly SA	3-00.26
15.	Helios France	3-03.56

THE RACE, DAY 1 SUNDAY 19 OCTOBER

It's an early rise on race day. Cars commence assembling on the start from 6.30 AM in order of qualifying. Each is accompanied by its follow car. The other support vehicles and trailers are arranged out on the Stuart Highway some distance from the start. Final packing and positioning of the fleet happens under some pressure. This is it. All the preparation comes down to the silent start precisely at 8.00 AM.

The Aurora team has grown by three. It consists of David Fewchuk, Peter Pudney, Mark Gilligan, Stella Ngondi, Tony Vriens, Dennis Thoroughgood, Caroline Murphy, Eli Thurrowgood, Tom Baker, Darren Trafford and Paul Jolly. As well, Bill Bennett, David Snowden and Bonne Eggleston have joined for the trip to Adelaide. David and Bonne were to be part of the UNSW team that withdrew from the event.



Aurora 101 member Darren Trafford on his first commercial flight

The people of Darwin know a good show when they see one and a full grid of slinky solar cars is a good show. There's lots of media attention, many snapping their last pictures and interviewing drivers about their chances. The drivers are mostly buried in their streamlined cars, heads full of radio communication equipment ready for the hatch to come down and for the fleet to roll silently down the Causeway, negotiate the roundabout and start the long journey on the Stuart Highway to Adelaide. A police escort will take the field out to major Berrimah intersection after which the jostling for position can really take place.



Aurora 101 awaiting the start in Darwin



Aurora 101 in number 1 grid position, fastest qualifier



Aurora's lead driver Tony Vriens prepares for Race Start, Sunday 19 October 2003



Detleff Schmidt, the famous 'suitcase man' at the Darwin start

The experienced drivers must all wonder if there will be an incident in the short distance before the roundabout. They probably think of Solar Motions, the American entry that in 2001 crashed at that very place losing 6 hours in repairs. Aurora 101 is piloted by its most experienced driver Tony Vriens. He's done this several times before and in 1996 suffered an accident just 32 kilometres south of Darwin.

The time ticks away, the grid is cleared by the Chief Safety Officer Peter Schloithe and the Chief Minister takes hold of the starting flag. It's 7.50 AM.

A last check of Aurora reveals a big problem, a flat front tyre. What a time for it to happen. The tyre team leap into action, produce the foot pump and get the pressure back up to 70 PSI. What ever caused the flat will happen again, but there is no time for a tyre change. Tony stays calm and watches for the flag to drop. He leads the field away with Formosan at his shoulder and MIT behind. Nuna II and Queens will have a bit of traffic to negotiate and will not be allowed to do so until Berrimah. The batteries are full, the solar array stays off until 30 km have been travelled.

Past Berrimah Aurora 101 shakes off the police escort and hits the best speed that remains legal. The Northern Territory is well known for having no speed limit on the open road but they have many restricted speed zones around the towns and certainly a great deal of town development south of Darwin itself. Still Tony has a good start and leads the field south. The support cars have joined up and the Aurora convoy look like a well organised team.

Aurora's strategist and road boss, Peter Pudney, has asked for a speed of 100 km/h, he expects to hold that most of the day.

The first stretch is 316 km to Katherine. Along the way is the Hayes hill, the only significant climb on the whole route. The front tyre is definitely losing pressure. Tony can feel it in the steering rods. Finally 225 km from Darwin a stop for a tyre change is required. That means a drive-wheel change and the first serious use of the 'Jolly' switch. It works but the team have to wave both MIT and Nuna past whilst they lose about 8 minutes on the side of the road.

Nuna II is on a mission and surprise MIT with a passing move before Katherine. The drier heat of Katherine is noticeable. But it's hot as Nuna II rolls into the first media stop at 11.35 AM. MIT is 2 minutes behind and Aurora 101 just 8 minutes behind. That's a tyre change. In spite of the police escort Nuna II has averaged 88.18 km/h on this first leg. Honda owns the record for this part of the race averaging 96.6 km/h in their win of 1996.



Spectators at the Katherine media stop, 316 km from Darwin

After a half hour mandatory stop when no mechanical work can be done on the cars, the lead cars are off, heading for the second media stop at Dunmarra 316 km away.

Only one other entrant arrives before the top three are gone and that is the US team Principia. That's the race taking shape already. Principia were 4th place finishers in the ASC last July but won't have the pace to stay with the leaders in this one. Following Principia are Queens, Formosun, Bockum, and Kelly the next Australian. We don't know about Southern Aurora but later learn that they reached Katherine in 11th place.

The speeds are now extremely fast as the fine weather promises a dash to Dunmarra. A report on the first leg is already on Aurora's website. The first three spread out. By 2.58 PM Nuna II streaks into Dunmarra having averaged 109.59 km/h since Katherine. This smashes Nuna's 2001 record of 96.6 km/h. Not too many battery reserve problems here.

MIT's Tesseract is 17 minutes further back and holding second place. They have averaged 100.85 km/h. Our observer friend Roslyn Jan says the team is fun to travel with but seem to vary their car speed a lot. Andy Heafitz the faculty adviser travelling with MIT is very experienced having worked with the early MIT teams when US solar car pioneer James Worden was around. How James would like these speeds.

Aurora 101 is sticking to its day long average speed plan and trails Nuna II by 30 minutes. Aurora has averaged 97.23 km/h from Katherine and is nicely ahead of its pace in 2001.

Only 5 cars will reach Dunmarra on the first day, but the first 3 are heading further down the road. It's late in the day and Aurora 101 leaves Dunmarra at 4.00 PM. There is officially one more hour of travel and Peter Pudney's strategy is on the line. He is being encouraged to reach the town of Elliott, 105 km further. The first cloud bank can be seen so the solar energy will slow things down.. Peter holds speed probably wondering where the empty point on the battery lies and finally drops speed just outside of Elliott. The news is that Aurora 101 has re-passed MIT and the two teams pull off the road for a campsite only 2 minutes apart. Nuna II is 44 km or 27 minutes ahead. All three teams have no recharging sunlight, just the evening gloom to consider tomorrow and a hope for morning sun. The Aurora team members freshen up with showers at the local caravan park and share dinner together around the solar car trailer. We learn that the Dutch are travelling in a group of 55 people. Imagine the cooking job there.

Small tents and swags are set up and most of the team are hoping for clear skies in the morning. Many of the backmarkers have not kept up or have had breakdowns so have trailed their cars to checkpoints including 'The Paradise' from Puerto Rico. Southern Aurora are having array problems and have dropped to 12th. Heliodes is still running.

Aurora 101 has covered 733 km on Day 1 for an average speed of 91.63 km/h and is in second place. It is 25 km further from Darwin than in 2001. Pacemaker Nuna II has covered 776 km at an average speed of 97.04 km/h. Their distance just beats the first day record distance of 775 km set by Honda in 1996.

THE RACE, DAY 2 MONDAY 20 OCTOBER

It's not a great morning with only weak sunlight. That's bad news for battery charging and for making Alice Springs by day's end. Peter Pudney is emphatic that covering the 755 km to reach Alice is an impossibility.



MIT's 'Tesseract' super-car soaks up the morning sun at Elliott, Day 2

Further down the road the massive Nuon team entourage is also sitting under a cloud bank. They lay out a large tarpaulin overlapping the main highway in order to protect Nuna II from any stone damage to their slick soft low rolling resistance Michelin tyres. Around 8.00 AM they roll on to the Stuart Highway and head for the next media stop at Tennant Creek. Their main support vehicle aptly named 'Mission Control' follows. It is full of lap top computers and also carries the official race observer. Team boss

Wubbo Ockels, Holland's ever only astronaut has instilled a lot of space program discipline into the team of Delft University students. Mission Control is just that. Protecting the tyres is part of the discipline.

But even extending to clearing the highway of road kill and tyre fragments? Sure enough. A special 4 person team led by Henk Jan has left an hour earlier to remove anything that might create an unwanted swerve or a flat tyre. There's plenty to remove especially after a night of truck traffic. Some of the kill is fresh, some parched by the sun. Welcome to outback Australia.

Aurora 101 gets away on time and by time they reach the Nuna II campsite the record shows they are only 27 minutes behind. MIT are a further 3.5 minutes back. Tennant Creek lies 250 km down the road.

Before long the sky brightens and the solar panels do their job. In fact it turns out to be an excellent solar day. But easterly and south easterly winds are becoming evident and will later have a effect on speed in spite of the sun.

The Tennant Creek media stop is on the other side of the town. The town's speed limits seem to last forever including a stretch at 40 km/h in the main shopping district. Nuna II arrives at 10.35 AM, having averaged only 81.82 km/h in the morning period. Aurora 101 has made up 6 minutes and has an official arrival time of 10.57 AM. The average speed is 85.32 km/h. MIT has dropped back a bit and are 7 minutes further back.



Spectators at the Tennant Creek media stop, 986 km from Darwin



Local spectators at Tenant Creek



Nuna I 2001 team leader Ramon (right) urging Nuna II at Tenant Creek, Day 2



Aurora 101 and MIT capture the interest of schoolchildren at Tenant Creek media stop, Day 2

The Nuon support group is out in force including Ramon Martinez the winning team manager from 2001. But someone has tipped off the local schools and class after class of school children arrive at the media stop to see these sun powered racers. They are well behaved and ask a barrage of questions. As usual most are about the method of getting in and out of the car, the temperatures experienced by the drivers and how fast do they go.

In spite of this good early run Peter Pudney is still certain that reaching Alice Springs on Day 2 is an impossibility. Only one car has ever done that being Honda in 1996.

Mark Gilligan takes over the driving duties knowing that whatever happens he is in for a long session even if Aurora does not reach Alice Springs. At 11.27 AM Aurora 101 is moving again. There is an unbroken 5.5 hours left in the race day.

Peter is still backing his even speed strategy and Aurora 101 is holding better than 90 km/h.. Around 4.00 PM there is an accident ahead. One of the Nuon media support vehicles has suffered a tyre blow-out and rolled. Nobody seems to be hurt badly although we learned later that two passengers were taken to the Alice Springs hospital for a check.

By late afternoon it started to look as if we could reach Alice. The approach is all downhill through the

hills on the north side. MIT was close behind and pleaded to be allowed to pass. But it was too late. Both teams were in restricted speed zones and in no passing areas. The media stop was there in front of us and the official arrival time was 5.04 PM just one minute ahead of MIT. Already Nuna II had completed their 30 minute stop and chose to camp a bit further down the road by still in Alice Springs. Three teams made it to Alice Springs in 2 days, joining the achievement of Honda in 1996.

Aurora 101 had covered 755 km on Day 2 at an average speed of 88.82 km/h. Driver Mark Gilligan had been concentrating for 5 hours 37 minutes. The Red Centre caravan park had great facilities, good showers and covered amenity areas. This was solar car racing in comfort. The sun was clear right up to sunset so the battery charge session was a good one. The morning would be as good.

Nine teams had passed through Tennant Creek on Day 2 with Queens gaining 4th place followed in fifth by Bockum. Principia had struck difficulties and had dropped to 7th behind the Apollo car from Taiwan. Southern Aurora had regained 10th position and Heliodet was still running, averaging a modest 37 km/h.

It was evident that Nuna II would have to suffer a major problem to be beaten so the Aurora plan started to focus on staying ahead of MIT and perhaps reaching Adelaide in 4 days.

THE RACE, DAY 3 TUESDAY 21 OCTOBER



Caroline Murphy saves Aurora's food preparation efforts

We had great morning sun and an extra half hour to soak it into the batteries. The team was refreshed, showered and replenished. The website was up to date and we were getting ready to go at precisely 8.34 AM. Nuna II was parked near a fast food outlet but also had great morning sun. With their powerful array they were sure to have full batteries for the 3rd day of racing. As usual the road cleaning crew left well ahead of the others.



NunaII's road kill sweeper Henk Jan in Alice Springs



Aussie roadkill! All removed by Nuna II team

Dick Duncan from North America was manager of the Alice Springs media stop. He had been involved as the recorder of weather data in previous WSC events. His wife had a special solar car quilt on display as record to Dick's long involvement with this technology. At the right time Dick waved the Aurora team away for the longest stretch of the race Alice Springs to Cadney Station, 538 km. It was Stella Ngondi's turn to face a long driving session.



Dick Duncan re-starts Aurora 101 and MIT from Alice Springs, Day 3

Our exit from Alice Springs was accompanied by a helicopter media crew. The road was clear, the sun was great but the winds were starting.

MIT's Tesseract was close behind and as the sun rose in the sky the superior power on MIT enabled them to pass Aurora 101. This happened at 11.00 AM. By midday the wind was having quite an effect. The side loads on the cars meant that the tyres were suffering a lot more wear, especially the single drive wheel. Stella had a risky moment when passing a road train on a fast downhill stretch of road. Speeds were around 100 km/h in spite of the wind. We were wondering about the tyre wear.

The media stop in 2001 had been Marla Bore some 456 km from Alice Springs. Aurora 101 passed through Marla Bore at 1.13 PM averaging 98.06 km/h, just a bit faster than in 2001. Cadney Station was still another 82 km.

At 1.19 PM Nuna II arrived at Cadney. They had averaged an outstanding 103.13 km/h since Alice Springs. MIT clocked in at 1.54 PM with a flat motor wheel tyre. Aurora 101 was 11 minutes further back with a worn out front motor wheel tyre. It was hot and windy and all three teams faced a tyre change. The rules say that this cannot be done whilst the cars are in their mandatory 30 minute stop.

MIT pushed their car out of the official stop zone to commence their tyre change. They had great difficulty removing the wheel and had not released it before it was Aurora's turn to do the same. This was a well rehearsed operation for Aurora and the new wheel was on in 3 minutes. MIT were losing precious time. Then Aurora was ready to activate the 'Jolly' switch to re phase the motor controller. It didn't work; the heat had softened the attachment adhesive. This required direct access to the motor controller. The top of the car was removed, the controller reset the top replaced and re taped but MIT were gone.



The tyre change race with MIT on departure from Cadney media stop, Day 3

Still, through this tyre change drama in the dusty gravel of Cadney Station Aurora had gained 6 minutes on MIT and hit the Stuart Highway only 5 minutes behind. Stella had completed a 5 hour 31 minute driving session and a close call.

With 2 hours 15 minutes to go the end of the day, Coober Pedy was a certainty. But how far past and what distance left to make Adelaide by the end of Day 4? How also to catch MIT?

Peter's plan was to hold 97 km/h. We had no telemetry on the solar panel and solar panel reinforcements loosening from the buffeting. By 4.08 PM we passed MIT. They were again fixing a flat tyre. Finally we passed Coober Pedy and its strange white mullock heaps and stopped next to a Telstra solar powered telecommunications repeater station. We were 2240 km from Darwin and still had 758 km to go to reach

the end of timing point on the outskirts of Adelaide.

The Telstra repeater station was a good omen as Telstra Country Wide had provided our essential satellite phones. Telstra, previously known as Telecom, had pioneered solar powered telecommunications system in outback Australia and in 1978 had installed a full system between Tennant Creek and Alice Springs.

The wind was strong. It rocked our solar panel as we lifted it to squarely face the late sun. We found broken telemetry wires that explained why we had no panel data. The silicone gun came out to repair the balsa support ribs behind the solar panels. Dinner was on.

In this windswept area, devoid of any trees you would think that flies would be few and far between. Not at all. They were out in force. Our observer was well equipped with an insect net draped from his bush hat.

MIT were 8 km behind but still too close for comfort. Nuna II was 84 km ahead having covered a mighty 835 km on Day 3. This broke the day distance record set in 1993 by Honda at 807 km. Certainly Nuna II was on pace to reset the race record and reach Adelaide comfortably tomorrow. But Aurora 101 would need to do its best day distance ever to reach Adelaide on Day 4 with 2 media stops taking a whole hour out of the running time. Peter thought it to be impossible.

By the end of Day 3 only 8 cars had reached Alice Springs and none but the top 3 had passed Cadney Station. Queens were firmly in 4th place about an hour ahead of Bockum and 2 hours ahead of Principia. Southern Aurora had dropped to 12th and Heliodet was still running. Was this the year for a Detleff Schmidt finish?



Aurora's fabulous Ford support cars at the end of Day 3



Aurora 101's overnight stop at Telstra solar powered repeating station south of Coober Pedy, Day 3

THE RACE, DAY 4 WEDNESDAY 22 OCTOBER

The 106 km dash to the next media stop at Glendambo had Nuna II arrive at 9.05 AM, with an average speed of nearly 98 km/h. This was an indication of what spectacular speeds this car would reach as the perfect solar conditions unfolded on Day 4. The gravel apron at Glendambo had the Dutch worried. As soon as their 30 minute stop was completed the solar car was gently driven on to the highway, stopped, and the wheels and tyres cleaned of any gravel. Then they were gone with the team in 'Mission Control' waving from all the windows. They knew it was to be their day.



Nuna II leads out of Glendambo media stop with Port Augusta and Adelaide to go, Day 4

Aurora 101 had 190 km to cover to reach Glendambo and did so in 2 hours at an average speed of 95.00 km/h. This was the speed needed all day to reach Adelaide. Peter seemed ready to try in spite of the computer predictions saying impossible.



Aurora 101 at Glendambo Media Stop on Day 4

MIT were 14 minutes further back and would have to fly to pass Aurora 101 today. At least they would need to preserve their tyres.

This was a perfect day. No wind, clear sun, moderate temperatures and incident free for the 289 km from Glendambo to Port Augusta.

Nuna II reached Port Augusta by 12.18 PM with an average speed of 106.38 km/h. They reported that they could travel at 108 km/h on solar energy alone. No need to watch the battery condition. The South Australian speed limit is 110 km/h. Travelling at the highway speed limit on solar energy alone makes a big statement about the future of solar and solar assisted transportation.

Aurora 101 arrived in Port Augusta at 1.33 PM trailing Nuna II by an hour and 15 minutes with an average speed from Glendambo of 95.75 km/h. MIT were a further 18 minutes back having lost more time to, you guessed it, fix another tyre. Evidently they were having radio communication problems and had to make a sudden stop at a set of traffic lights entering the town. The ensuing skid caused a puncture and that was that.

By the time of departing Port Augusta at 2.03 PM Aurora had 3 hours to cover the last 279 km to Angle Vale. This required good sun, few traffic problems and an average speed of 93 km/h. It was possible, maybe. The whole team were starting to learn about tension. The news from Adelaide was to expect cloudy conditions.

Not far down the road there was a traffic delay as an oncoming semi trailer had rolled into the adjacent field closing one lane. Still Peter asked for speeds of 95-97 km/h. By now the driver also had an extra gauge to keep check of the battery voltage. He started regular reports as the battery voltage became the only reliable measure of battery condition. With the lithium polymer battery system there is a minimum voltage point at which the batteries are destroyed. What's more as this is approached the voltage starts to drop rapidly.

Fingers were crossed all over the place. The terse exchange of battery condition information was heard by all the team on the two way radio system. Finally Peter had to crack and call for reduced speed. The clouds covered the route for the last 40 km, the battery was just about gone and there was a good prospect of not reaching the end point. The speeds dropped through 80, 78, 74, 70 and finally to 65 km/h. It seemed to take forever to reach that end of timing point at Angle Vale but finally at 5.07 PM there it was. We were home, in 4 days, with flat batteries ahead of the race record time from 2001. The sun then crept out from the horizon in congratulations.

Mark Gilligan's parents were there as were Tom Baker's. Tony Vriens had family also and soon we had gathered a group of fans by the side of the road. A campsite just down the road in a paddock of long grass together with showers and pizza was all the team needed. Pole starting position, 2 days to Alice Springs, 4 days to Adelaide and breaking the 2001 race record stacked up pretty well for the best ever performance of Aurora. We admired the speed of Nuna II and enjoyed making friends with this wonderful Dutch team. We were thankful for MIT's tyre problems. They were to finish on the following day just 15 minutes behind.

THE RACE, DAYS 5-10 23-28 OCTOBER

Aurora 101 had one last duty to perform and that was to cross the official finish line in the centre of Adelaide City. At 8.00 AM the team left Angle Vale and joined the peak hour traffic to crawl into the city. This was probably the most dangerous part of the race.



Aurora 101 crosses the finish line, second to Nuna II

Finally the support cars reached the centre, the solar car was channelled into the lane reserved for solar cars and made the last 50 metres to finish under the archway at the end. Some of the Nuon team were there to greet us as were other bystanders on their way to work to wonder what this was all about. The bubbly was discreetly put aside to make sure the spray stayed away from the solar panel. The solar car was put on display next to Nuna II and the team relaxed to await other finishers.

Six teams finished this 7th World Solar Challenge by the end of the fifth day. These were:

1. Nuon Solar Team	Holland	Nuna II	3.34 PM 22 Oct	30 hrs 54 mins	97.02 km/h
2. Aurora Veh. Assoc.	Australia	Aurora 101	5.07 PM 22 Oct	32 hrs 37 mins	91.90 km/h
3. MIT Solar Team	USA	Tesseract	8.22 AM 23 Oct	32 hrs 52 mins	91.20 km/h
4. Queens University	Canada	Gemini	1.46 PM 23 Oct	38 hrs 16 mins	78.33 km/h
5. FH Bochum/SBU	Germany	HansGo	4.26 PM 23 Oct	40 hrs 56 mins	73.24 km/h
6. Principia College	USA	Ra V	4.50 PM 23 Oct	41 hrs 20 mins	72.53 km/h

The Queens finish saw lots of Canadian flags produced. They were the first two seat solar car to finish.



Queens team member at the Adelaide finish line



The two seater Queens entry reaches Adelaide in 4th place

A special German musical and dance troupe saw the HansGo entry across the line in the first time effort for this team. Hans Gochermann was proudly present at the finish line to see many cars finish with solar panels made at his factory in Hamburg.



Germany's Bockam University team welcomed in German fashion



More of that German welcome

Principia were welcomed in by a travelling Alumni group from that small University led by Dr. David Cornell. Dr David even led the crowd in singing the University song. Later he acknowledged Art Boyt from Crowder College in the USA for helping Principia develop a solar car team. Art and Dan Eberle

[Director of the American Solar Challenge, and present during this WSC] are distinguished for having completed the first solar car crossing of America in 1984. Their 1984 car is on permanent display in the Henry Ford Museum in Detroit.

Only three more cars finished on Day 6, Southern Aurora in 10th place on Day 7 and finally Heliadet on Day 10 at an average speed of 36.20 km/h. It was a great achievement for Detleff Schmidt the suitcase man from Munich.



Aurora's David Fewchuk and Nuna II's Wubbo Ockels exchange shirts



John Hoerner, Director of Sunrace and Michelin tyre representative in Adelaide



Southern Aurora finishes tenth

The official finishers can be found on the event website <http://www.wsc.org.au>.

Members of the Aurora team stayed in Adelaide to show the car to both the public and to the school teams participating in the model solar car racing at the same place. Lots of team shirts were swapped, Lots of parties attended in the evening. This was certainly one of the friendliest WSC events ever.

RACE SPEED IN PERSPECTIVE

Nuna II's achievement is a dramatic statement of the progress made since GM won the first WSC in

1987. The average speed for the GM Sunraycer was 66.90 km/h. That would have been good for place in 2003. Three teams have now bettered a 90 km/h average speed for the event, Nuon, Aurora and MIT. The top ten performances in the history of the World Solar Challenge are as follows:

1.	97.02 km/h	Nuna II	2003
2.	91.90 km/h	Aurora 101	2003
3.	91.81 km/h	Nuna I	2001
4.	91.20 km/h	MIT	2003
5.	90.26 km/h	Aurora RMIT 101	2001
6.	89.76 km/h	Honda	1996
7.	87.37 km/h	Michigan	2001
8.	86.00 km/h	Biel	1996
9.	84.96 km/h	Honda	1993
10.	81.88 km/h	Solar Motions	2001

ACHIEVING A 100 KM/H AVERAGE SPEED

This is harder than it seems. In 2003 Nuna II would need to have been 1 hour quicker. Speed limits in South Australia have been reached and would now be a limiting factor in the latter half of the event.

The key to achieving 100km/h average is in going faster in Northern Territory. Progressively there are more speed limited areas in Northern Territory. The police escorted start to the event represents a time loss. Then perfect weather is required over the first 4 days.

THE GOCHERMANN FACTOR



Master panel builder Hans Gochermann. Seven entries used his solar panels

Six and a half cars used solar panels produced by Gochermann Solar Technologies. The teams were Nuna II, Aurora 101, Bochum, Southern Aurora [half car], Malaysia, Heliodes and Helios III.

These cars had reliability and flexibility. The special surface finish improved panel performance in angled light conditions. The Gochermann technique of building solar panels is equally applicable to

most types of solar cells. The triple junction solar cells used on some of the Aurora 101 panels were the first of this type to be shingled to achieve more working area for the panel overall.
