



Investigation into the accident of Richard Hammond

Accident involving RICHARD HAMMOND (RH)
On 20 SEPTEMBER 2006
At Elvington Airfield, Halifax Way, Elvington
YO41 4AU

SUMMARY

1. The BBC Top Gear programme production team had arranged for Richard Hammond (RH) to drive Primetime Land Speed Engineering's *Vampire* jet car at Elvington Airfield, near York, on Wednesday 20th September 2006. *Vampire*, driven by Colin Fallows (CF), was the current holder of the Outright British Land Speed record at 300.3 mph.
2. Runs were to be carried out in only one direction along a pre-set course on the Elvington runway. *Vampire*'s speed was to be recorded using GPS satellite telemetry. The intention was to record the maximum speed, not to measure an average speed over a measured course, and for RH to describe how it felt.
3. During the Wednesday morning RH was instructed how to drive *Vampire* by Primetime's principals, Mark Newby (MN) and CF. Starting at about 1 p.m., he completed a series of 6 runs with increasing jet power and at increasing speed. The jet afterburner was used on runs 4 to 6, but runs 4 and 5 were intentionally aborted early.
4. The 6th run took place at just before 5 p.m. and a maximum speed of 314 mph was achieved. This speed was not disclosed to RH.
5. Although the shoot was scheduled to end at 5 p.m., it was decided to apply for an extension to 5:30 p.m. to allow for one final run to secure more TV footage of *Vampire* running with the after burner lit.
6. The 7th run commenced at 5.25 p.m. and seemed to be proceeding satisfactorily until approximately 14.25 seconds and 1120m into the run, and with *Vampire* travelling at 288mph, the right front tyre blew out instantaneously.
7. *Vampire* veered to the right, and ran off the runway into the grass outfield. The car dug in and rolled over several times and then flipped over, coming to rest, upside down, in the outfield approximately 60m from the runway.
8. RH was removed from *Vampire* by the on-site fire and rescue and paramedic teams and was taken by the Air Ambulance to the Regional Head Injuries unit at Leeds General Infirmary.
9. He suffered superficial facial injuries and also bruising and swelling to the brain due to head acceleration effects. After an initial period of concern, followed by a period of several

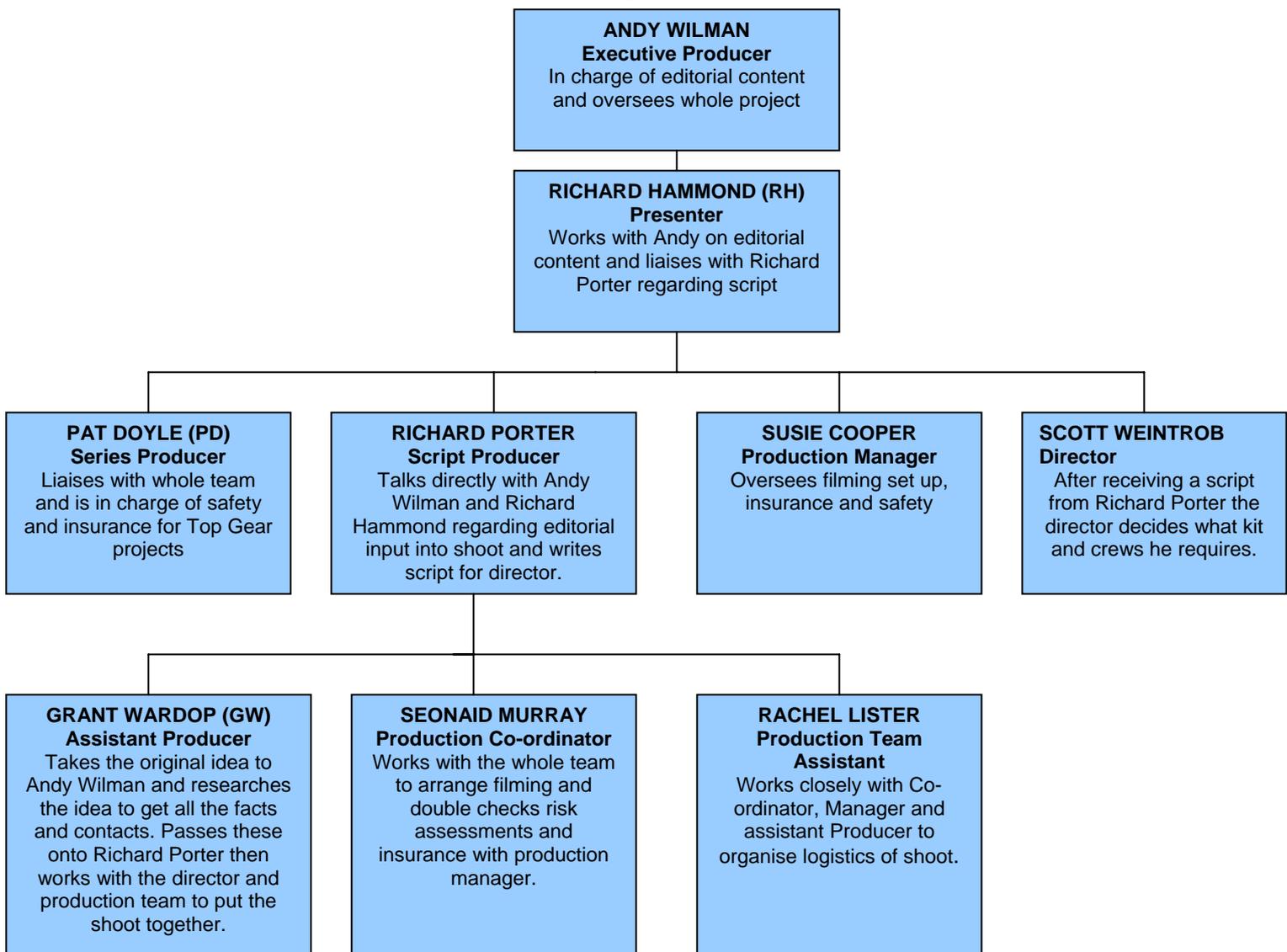
weeks when his short-term memory was adversely affected, he seems to have made a full recovery.

PARTIES INVOLVED and THE SITE

The BBC Top Gear Production team

10. Top Gear is an in-house BBC production that comes under the Factual and Learning Division of TV Programmes. The programme has a small, dedicated production team headed by the Executive Producer, Andy Wilman, who has been with the programme since its relaunch in 2002. The current Series Producer is Pat Doyle (**PD**). The structure of the team and the jobs of team members involved in the Elvington shoot are shown in the diagram below.

****The Top Gear Team****



11. Top Gear is Andy Wilman's only programme, which is unusual in the BBC, and he is very hands-on. The team worked as a close-knit unit in an open-plan environment and the production process was said to be very "organic"

12. The three presenters are Jeremy Clarkson, RH and James May who are all self employed. They are contracted to the BBC but also do 'freelance' work.

Primetime Land Speed Engineering (PTLE)

13. PTLE is a part-time collaboration between CF and MN for the purpose of carrying out land speed record attempts, and displays. They have been working together since 1994 and currently run 3 specialist cars. Two of these, *Vampire* and the newer *Split Second*, are powered by jet engines, and the third, *e=motion*, is powered by electric batteries. They routinely used Malcolm Pittwood, a freelance motor sport consultant, as their project / event manager and called on family members and support technicians as and when required.

14. CF had worked as an engineer at the Santa Pod Raceway, the principal venue for drag racing in the U.K. He was part of the team that built two identical jet powered drag racers, *Vampire* and *Hellbender* in 1981. The cars utilised ex-Red Arrows Rolls Royce Orpheus jet engines and were built to comply with the then current American standards for such cars.

15. The two jet cars were prominent in the British drag racing / jet car scene until *Hellbender* was involved in a fatal crash in 1986 at Santa Pod. *Hellbender* suffered a suspension failure whilst participating in a side-by-side drag race with *Vampire*, driven by CF.

16. Following a change of ownership of Santa Pod, CF bought *Vampire* in 1988 and has been using it ever since. The car has been modified and upgraded over the years. The Orpheus jet engine, which normally produces peak thrust of between 3000 and 3500lbs thrust, has been fitted with an afterburner that increases the engine's thrust to 5000lbs.

17. CF set a new Outright British Land Speed record of 269 mph in *Vampire* at Elvington in 1999. In July 2000, again at Elvington, MN raised the record to 272 mph in *Split Second* only for CF to raise it again to the current record of 300.3 mph 2 hours later in *Vampire*.

The Site

18. Elvington Events Ltd operate the airfield. It is five miles southeast of York and hosts the largest air show in the north of England every August. The runway is 3000-metre long and is used for aircraft exhibitions, Formula One testing, sports car and police driver training, land yachting, land speed record attempts, and corporate events. Further details can be found on the operator's website (<http://www.elvingtonairfield.co.uk/>).

CIRCUMSTANCES - leading up to and including the crash

19. The Top Gear programme was relaunched in 2002 with a new format that has been very successful. This format revolves around live studio presentation, and features including car tests, regular features, and one-off stunts. Jeremy Clarkson, RH and James May present the show in an irreverent but humorous style. The Executive Producer, Andy Wilman, has been central to this new format.

20. There are normally two series of Top Gear per year, each of 8 to 10 programmes. The production team have an "Ideas Board" on which are put ideas for features and stunts for the series, either thought up by the team, or suggested by members of the public or other organisations. Ideas are taken from this board when programmes are being planned in outline and are then worked-up by the production team. There are normally 4 'filmed'

features per show. Thus the team would normally produce up to 80 short 'filmed' features per year.

21. About 2 years ago RH had expressed a wish “ *to go really, really fast, faster than supercar fast* “, and this had been put on the Ideas Board, but not actioned.

22. PTLE had arranged to use the runway at RAF Fairford on 5 July 2006 for an official attempt on the Outright British Land speed Record. They were also to be featured at the Royal International Air Tattoo, also at Fairford, two weeks later.

23. PTLE brought this information to Top Gear's attention and suggested that they might like to cover the record attempt. Top Gear contacted Malcolm Pittwood, who was managing the two events for PTLE. Top Gear does not cover events as such, but it was suggested that if one of their presenters could drive one of the jet cars then it would make a good feature.

24. Malcolm Pittwood told the BBC that direct Top Gear involvement was not possible because all the arrangements and the necessary approvals were in place for the Fairford events and could not be changed. He said that PTLE might consider a stand-alone Top Gear feature that would involve a presenter driving one of their cars. Members of the principals' families, Colin Goodwin, a journalist with Autocar, and several enthusiasts had been put through a short training programme and had driven the *Vampire* jet car.

25. Andy Wilman decided to pursue this offer and linked it to the “*really, really fast*” storyline. Assistant producer Grant Wardrop (**GW**) was asked to develop the idea with PTLE. It was originally intended that James May would be the driver because RH already had a lot of features in the new series. This would be somewhat incongruous because James May's nickname on the show was 'Captain Slow'.

26. GW did some background research about PTLE. He found that they were a well-established team and at the forefront of the domestic jet car and land speed record scene. PrimeTime claimed to have completed approximately 3000 runs in *Vampire* without accident.

27. GW initially proposed a Top Gear attempt on the Outright British Land Speed record, but Andy Wilman quickly vetoed this because it greatly increased the complexity and risks associated with the feature.

28. Before Top Gear committed to the project, Richard Porter, the script producer, contacted Colin Goodwin, a motoring journalist who had done a similar feature about driving *Vampire* for Autocar in 2001. This had culminated in an afterburner run with a maximum speed of 260 mph. He told Richard Porter that PTLE were serious people, and that he had been impressed by the quality of their equipment and by the thoroughness of the training that he had been given which was “*as good as anything that he had had from Porsche*”. He said that a motoring journalist with experience of driving high performance cars, and who was prepared to do as he was told, could be trained up in a day to drive *Vampire*.

29. The project became known as “*Vampire – the need for speed*” and was developed, mainly by telephone calls between various members of the production team and CF, and by exchange of correspondence. As formulated, the feature would involve on-the-day training for RH and a series of progressively faster one-way runs. The intention was to eventually post a headline maximum speed approaching 300 mph.

30. PTLE proposed 4 possible venues, and gave available dates. Taking the Top Gear team's availability into consideration, it was decided that Elvington Airfield, near York, would be used. This site has a runway that is 3000m long, but it is not an operational airfield. PTLE had used Elvington for earlier record attempts, and so were familiar with the site.

31. Elvington was booked for 2 days, 20th and 21st September 2006. This was to allow enough time for training and filming and also to allow for bad weather, PTLE did not want the jet car to run in the rain.

32. When the timetable was finalised it became clear that James May could not be the presenter because of a diary clash. RH was available, and needed no second asking.

33. RH also spoke to Colin Goodwin, whom he knew. He told RH that he must take the event very seriously. Driving *Vampire* was exciting, but it required complete concentration.

34. After consultation with Elvington Events Ltd, arrangements were made for their usual emergency teams, Fire Event Services, and Inter-County Paramedics, who had extensive motor sport experience, to cover the event. Both teams were familiar with the Elvington site, having covered the annual air show and various motor sport events that were held there, and had worked together in the past.

35. Racelogic Ltd was engaged to monitor the runs. This company specialises in motor sport telemetry, using GPS sensors fitted to a car and linked by radio to a specially programmed computer. The data recorded is processed to produce various readouts of speed, acceleration and distance travelled in three dimensions. The information generated could be presented in a number of ways, and the various runs could be compared against each other.

36. This investigation, done jointly with North Yorkshire Police, has relied on Racelogic's data for the timing of the various runs and has used Racelogic's telemetry data, as necessary, to reconstruct the various runs.

Visit by Ben Collins (BC) to PTLE

37. The preliminary arrangements for the event had been made at arm's length, with the result that, as the date of the Elvington shoot approached, no-one from Top Gear had actually met PTLE's principals or seen their jet cars. The jet car feature was considered to be sufficiently unusual and hazardous for GW to ask BC, who worked closely with Top Gear as a high performance driver and consultant, to go and see PTLE and *Vampire*, and to prepare a briefing for RH. It was felt that, with his extensive motor sport experience, he would be able to confirm PTLE's competence and the quality of their equipment, and be able to see through them if they were not genuine. (This was a significant step because Top Gear had not used BC in this way before.)

38. BC visited PTLE's premises near Northampton on Monday 18th June. He seems to have been convinced of their bona fides. He telephoned PD to confirm his conclusions and prepared a briefing paper that he e-mailed to GW. This described *Vampire's* controls and tried to prepare RH for the experience of driving the jet car.

Personal protective equipment

39. RH was provided with a new set of Sparco fire resistant racing overalls, balaclava and gloves and a new Arai GPR GP-5/k racing helmet. This was to the highest standard, and as used by Formula 1 drivers.

40. He also wore a foam neck collar that was designed to minimise head movement in the event of a crash and to reduce the risk of concussion and whiplash injuries. (At one stage it was suggested that he should wear a HANS head restraint, as now worn in Formula 1.)

Preliminaries at York

41. PD and RH drove up to York on 19th September and met MN and CF in the hotel to discuss what was proposed for the following day and to have a general discussion about driving *Vampire*.

42. The weather forecast for the 20th September was satisfactory, although a southerly crosswind was forecast. However, the forecast for the 21st September was for bad weather (although this forecast proved to be wrong). On account of this adverse forecast it was proposed to complete the shooting on 20th September. PTLE agreed to tailor their training programme to fit this timetable.

Preparation at Elvington

43. The PTLE team arrived at Elvington early and began to prepare *Vampire*. The car was set up for CF, the normal driver. No adjustment of the seat was required for RH because he and CF were about the same height. *Split Second* had also been brought to Elvington, but was not used.

44. The GPS telemetry sensors and the mini-cameras were installed in the car. One mini-camera was installed on the dashboard pointing back at the driver. A second mini-camera was mounted on a clamp that was attached to the top of the roll cage. This camera could be swivelled around to point either forwards or rearwards. RH also had a radio microphone fitted inside his crash helmet.

45. Malcolm Pittwood was in charge of the airfield preparation. He also liaised with the BBC production team on set up, logistical and safety issues so that the planned camera shots could be obtained.

46. The runway was inspected and checked for any debris. A measured course 0.8 miles (1290m) long and running from east to west was set up on the runway. 2 large green cones indicated the end of the course, one at each side of the runway. This indicated the point at which the driver should shut down the jet engine and release the primary parachute. The course length had been chosen so as to allow a maximum speed of about 300mph to be achieved when the afterburner was used.

47. The morning was taken up with preparations for the filming, some static filming of *Vampire* and of introductions and set piece meetings. RH's training proceeded as a series of briefings and in-car instruction. He said (when seen) that he had been happy with the pace and content of the training that he had received.

48. At 10.34 a.m. CF did a 'shake-down' run in *Vampire* with the jet after-burner ignited to make sure that the car, the mini-cameras and the telemetry were working correctly. He did not complete the full course before pulling the parachute. This preliminary run achieved a maximum speed of 266 mph.

Pre-run checks and start up procedure

50. Before each run the PTLE team ran through a series of standard checks on the car and the jet engine. These checks were dictated by and recorded on a checklist, along with any comments. Copies of the completed checklists covering the first 6 runs were later supplied to HSE. There was no completed checklist available for the final run.

51. BBC personnel and film crew later commented that the PTLE team had looked professional and had been busy between runs "*doing jet car stuff*".

52. The BBC film and audio records show that the same routine was followed at the start of each run. The driver's seat was fitted with a racing specification, five point Simpson safety harness. MN strapped RH in tightly. Closely supervised by CF, he then went through a series of cockpit checks and followed a set start-up routine. RH then followed CF's instructions about setting the power level of the jet whilst he held *Vampire* stationary on the footbrake. CF then backed diagonally away from the front of the car (so that he could still be seen by RH) and then signalled to him when it was safe to release the brakes and start the run.

53. At the end of the run RH was debriefed, the parachute was repacked into its canister, and *Vampire* was turned around and towed back to the start line

RH's jet car runs

54. When everything was in place and his preliminary training had been completed, RH performed a series of runs in *Vampire* with increasing jet power. The afterburner was not used for the first three runs. A summary of these runs is as follows:-

- 12:54 pm - RH's first run - maximum speed of 206.1 mph achieved.

(It may be noted that Colin Goodwin had not exceeded 200mph until his fourth run)

After each run RH did an immediate piece to camera to capture his reactions.

- 1:44 pm - RH's second run - maximum speed of 210.3 mph achieved.
- 2:53 pm - RH's third run - maximum speed of 220.4 mph achieved.

There was then a brief lunch break. PTLE seem to have been happy with the progress that RH was making and it was agreed that he could proceed to use the afterburner after lunch.

55. To help build the tension, the script called for a '*chicken-out run*' in which RH seems to get scared and pulls the parachute lever prematurely because he feels that *Vampire* is drifting off-line. This would be captured in the piece to camera after the run and by the in-helmet microphone.

- 3:36 pm - RH's fourth run. This was intended to be a '*chicken-out run*'. The afterburner was used but did not ignite properly, and went out after a few seconds. The run was aborted after about 780m. A maximum speed of 205 mph was recorded

In the debriefing after this run, it was decided that although RH had pulled back on the afterburner fuel lever, he had not pressed the afterburner igniter switch on the steering wheel for long enough.

(The afterburner igniter works by injecting additional fuel into the jet engine inlet. The fuel passes through the engine, is ignited and is discharged, still burning, into the jet exhaust where it ignites the afterburner fuel that is being injected into the jet exhaust. This method of ignition is necessary because the normal jet exhaust is not hot enough to ignite the afterburner fuel; it just vaporises and discharges as a cloud of white vapour. RH was cautioned that depressing the igniter switch for 'too long' would do serious damage to the power turbine).

- 4:21 pm - RH's fifth run. Another '*chicken-out run*'. The after burner ignited properly, the run was aborted after 576m and a maximum speed of 234 mph was achieved
- 4:56 pm - RH's sixth run. A full-length run with afterburner. This gave a maximum speed of 314 mph. The jet shut off distance is recorded as 1519m, which is consistent with the earlier runs and approximately 230 m beyond the cones. (At 300 mph the time taken to travel 200m is approximately 1.5 seconds)

56. RH was very elated after this last run, which had seemed to go perfectly. One of the PTLE team is heard to say "*That was highly impressive*". RH was not told the maximum speed although it was known to PTLE and to the Top Gear production team. It was intended that CF would tell him the maximum speed after the final run so that his immediate reaction could be captured on film.

57. It was now 5:00pm, the time limit of the BBC's booking. RH was keen to have another run. PD telephoned Andy Wilman and it was agreed to go for another run to obtain more footage of the car running with the afterburner lit.

58. Elvington Events were consulted and agreed to a half hour extension if the BBC would handle any complaints from the neighbours – the original 5:00 pm limit had been set so as to mitigate noise nuisance.

- 5:25 pm - RH's seventh and final run. This run was analysed in full by the North Yorkshire Police Collision Investigator.

To summarise, the seventh run seemed to be proceeding satisfactorily. However, at approximately 14.25 seconds and 1120m into the run, with *Vampire* travelling at 288mph, the right front tyre blew out instantaneously.

59. *Vampire* veered to the right, and the rear of the car began to spin round until eventually the car was sideways on to the line of travel. Having travelled a further 220m, it ran off the runway into the right hand grass outfield. The left side of the car dug in causing the car to roll over several times and then to flip over, coming to rest upside down in the outfield approximately 60m from the runway.

60. The main parachute seemed to have deployed as the car was running on to the grass, but the canopy did not have time to form before *Vampire* started to roll.

61. The paramedic tender reached *Vampire* within 10 seconds to find the car upside down. Following the final end-to-end flip, the car had been travelling forwards whilst upside down before it finally came to rest. The roll cage had dug into the ground causing soil to be forced into the cab. RH's visor had become displaced and soil had been forced into the helmet.

62. The Fire and Rescue team and the production crew were quickly in attendance and *Vampire* was rolled back onto its wheels, and the soil was cleared from RH's face. The Fire and Rescue crew used hydraulic shears to cut through the roll cage tubes, and lifted the roll cage off the car. RH was carefully lifted out of the car and placed on a backboard. He was semi-conscious for some of the time and at one point talked about doing a piece to camera. The air ambulance was called and reached Elvington after about 15 minutes. RH was then airlifted directly to Leeds General Infirmary.

DAMAGE and INJURIES

Damage to *Vampire*

63. The tubular chassis of the car appeared to be remarkably undamaged, and there had been no leaks from the fuel system.

64. The left side front wheel and brake assembly had sheared off at the stub axle, as it was designed to do, and was found about 80m beyond the car.

65. The right side front suspension was badly damaged but remained attached to the car. The right front tyre was almost entirely delaminated, but remained attached to the wheel.

66. The glass fibre nose-cone assembly had been knocked off and also showed signs of abrasion on the underside where it had skidded along the runway after the tyre failure.

67. The top cover for the part of the car in front of the cab was found quite close to the car, it is not clear if it became detached or was removed during the rescue

68. The glass fibre tail fin, and the left side parachute storage canister had been knocked off. The right side parachute canister was knocked out of position, but remained attached to the car.

69. The jet engine discharge tube, and the heat shield above it, had both been bent inwards as a result of a heavy impact.

Crash helmet damage

70. The Arai crash helmet had withstood the crash without any significant structural damage. There were, however, two impact damage marks to the right and to the rear of the crown of the helmet where the helmet had evidently struck against a bar-like object

71. As RH sat in *Vampire's* cab there was significant clearance between the rollover cage and the top of his crash helmet. He was very tightly strapped down by the 5-point harness, which allowed him very little body movement.

72. The inside of the roll cage tubes was lined with motor sport specification, high-density foam strips to protect against head injury.

73. PTLE have expressed surprise at the extent of RH's head injuries, citing a number of higher speed crashes from which the driver has emerged unscathed. They have thus suggested that the mounting clamp for the roll cage mini-camera may have caused the damage to the safety helmet. They suggest that this may have been rotated onto the inside of the safety cage when the car rolled over, and that the crash helmet may have struck against it.

74. The mini-cameras and their mountings were removed from the car by the film crew before the Police secured the scene and so we have no photographic evidence as to the position of the top clamp after the crash. The clamp itself was simply taken back into stock and it has not proved possible to identify it.

75. The HSE investigation team takes note of PTLE's comments and accepts that the clamp may have caused the damage to the crash helmet and may thus have been an exacerbating factor.

Injuries sustained by Richard Hammond (RH)

76. Superficially RH had suffered remarkably little injury. He had some facial bruising and a minor eye injury due to soil ingress into his helmet. The 5-point harness had held him firmly in the driver's seat and the arm restraint straps had prevented his arms from being thrown outside the confines of the cab.

77. His main injury was due to concussion and shock loading of the brain that, in the short term, caused his brain to swell. This injury initially gave cause for serious concern, and RH was transferred to the Neurological Intensive Care Unit at Leeds General Infirmary where his condition was classed as critical for some time. Fortunately the brain swelling subsided and he was well enough to return to Bristol to convalesce two weeks later.

78. Over a period of weeks, RH suffered from decreasing symptoms of short-term memory and concentration loss. By mid-December he was fit enough to attend an interview at the HSE Bristol office. Perhaps surprisingly, he retains quite a good recollection of the events at Elvington.

INVESTIGATION (HSE / North Yorks Police)

79. At the start of the investigation the following lines of enquiry were identified

- 1. Planning and preparation carried out by the BBC and PTLE for and during the film shoot at Elvington.**
- 2. The training given to RH by PTLE in connection with his use of 'Vampire', as an item of work equipment, and**
- 3. Post accident technical examination of 'Vampire' and its tyres.**

In connection with these matters (and following on-site discussions with the principal parties and the BBC's legal representatives) separate letters were written to the BBC and PTLE on 22 and 27 September respectively, requesting the following evidence and information:

From the BBC –

- i. Full copies of the video and audio footage that was recorded at Elvington on 20 September.
- ii. Telemetry data generated on the day.
- iii. The mounting brackets that were used to secure the cockpit cameras that were fitted to '*Vampire*' jet powered vehicle.
- iv. A copy of the BBC's contract and / or any formal agreement with Primetime Landspeed Engineering for the use of '*Vampire*'.
- v. An 'Organogram' setting out the roles and responsibilities of those persons involved in the preparation, planning and implementation of these arrangements for the filming that took place at Elvington.
- vi. A copy of the BBC's general and /or site-specific risk assessments for the filming and recording that took place at Elvington.
- vii. A copy of the script that had been generated for the film shoot and any amendments made on the day.
- viii. Details of arrangements that had been made to ensure that competent persons were available to deal with foreseeable emergencies.
- ix. Copies of any documentation supplied to the BBC by PTLE in advance and / or on 20 September concerning operation and maintenance of *Vampire*.

From PTLE –

- i. Background information relevant to the origin and activities of partnership known as PTLE.
- ii. Information relevant to design, age, manufacture, ownership history, management and use of the '*Vampire*' and 'sister' jet cars operated by PTLE.
- iii. A copy of PTLE's Health & Safety Policy statement,
- iv. A copy of PTLE's risk assessment for use of *Vampire* in the film shoot at Elvington on 20 September,
- v. Names of and roles played by any representatives of PTLE (including Malcolm Pittwood) in pre-planning and onsite arrangements for use of *Vampire* at Elvington,
- vi. Copies of any correspondence and / or agreements that PTLE and / or its Team Principals exchanged with the BBC relevant to use of vehicles owned or operated by PTLE, including *Vampire* in advance of and leading up to the film shoot at Elvington.

80. The video and audio footage was copied at the BBC's studios in Leeds on 22 September. Responses to the requests made in HSE's letters were received from the BBC and PTLE and on 2 and 3 October respectively.

81. North Yorkshire Police (NYP), following examination at the scene, took *Vampire*, its tyres and the racing helmet worn by RH into possession.

82. North Yorkshire Police (NYP) and Transport Research Laboratory (TRL) assessed the structural integrity of *Vampire* and the tyres respectively. TRL was instructed to consider:

- a) The reason for the failure of *Vampire*'s front offside tyre,
- b) Whether the tyres were suitable, and
- c) Whether any of the other tyres fitted to *Vampire* had started to delaminate.

83. PTLE and the BBC have been kept advised throughout of progress with the technical aspects of this investigation. The BBC appointed their own consultant to examine the tyres. Those parts of *Vampire* retained for examination and its tyres have now been returned to PTLE. The Arai GPR GP-5/k racing helmet supplied to and worn by RH at the time of the accident was returned to the BBC on 7 November 2006.

84. Issues relevant to the planning and preparation for the film shoot and training given to RH to drive *Vampire* were pursued by HSE. Following consideration of the information and evidence requested and received (see above), interviews of the following witnesses took place -

- i. (On 9 October, in Northampton) - MN and CF – PTLE Team Principals
- ii. (On 7 & 8 November, in London) - PD – Top Gear Producer, Jon Ling – Principal Risk Manager, GW – Top Gear Researcher, Paul Bamford - Freelance Cameraman.
- iii. (On 12 December, in Bristol) – RH, Presenter and BC - Driving Consultant.

85. NYP were present and provided technical support for the interviews that took place on 9 October and 12 December.

86. Mike Gray, Principal Specialist Inspector (HSE) reviewed the audio and video footage. He was then asked to review the ergonomics issues relevant to the crash.

CAUSE

87. The NYP Collision Investigation Report makes it clear that an almost instantaneous blow out of the right side front tyre caused the accident.

88. There is no evidence from the video films or from the telemetry, that RH was braking the car before the accident.

89. The Transport Research Laboratory report suggests that sometime during the penultimate run the right front tyre picked up a small pointed foreign body (or bodies) which pierced the outer tyre casing just at the inside edge of the tread. This seems to have caused a blister in the outer side which was evident on the film at the end of the penultimate run, but

which then seems to have subsided. The report confirms that the bulge was not apparent at the start of the final run, indicating '*that 'air' from inside the tyre was escaping into the tyre structure but not escaping from the tyre*'.

90. RH's instantaneous reaction to the tyre blow out seems to have been that of a competent high performance car driver, namely to brake the car and to try to steer into the skid. Immediately afterwards he also seems to have followed his training and to have pulled back on the main parachute release lever, thus shutting down the jet engine and also closing the jet and afterburner fuel levers. The main parachute did not have time to deploy before the car ran off the runway.

91. RH seems to have displayed considerable presence of mind, and to have managed to deploy the parachute following the blow out, albeit too late for it to be effective.

92. The NYP report, having studied the parachute deployment times for earlier runs, suggests that the accident may not have been recoverable even if RH had reacted perfectly and with no more delay than was humanly possible.

93. Mike Gray, senior HSE ergonomist, doubts that any person, however adept and accustomed to high performance driving, can be trained in such a short length of time to unlearn a long-ingrained reflex action, such as stamping on the brakes in an emergency, and to replace that reflex action with a new one, namely to pull back on the parachute / engine shutdown lever in the event of a malfunction such as a tyre blow out. The driver may take the appropriate action, as RH seems to have done, but this will be as a result of a reasoning process during an emergency situation and will inevitably take longer than a well-practiced reflex action.

94. Combining the human and mechanical system response times and comparing them with the time between the tyre blow out and *Vampire* crashing off the runway, suggests that the situation was not recoverable, even by an experienced jet car driver.

MANAGEMENT of HEALTH and SAFETY

BBC

95. This section of the Report is based on interviews with the Top Gear (TG) production team and Jon Ling (Principal Risk Manager) and the BBC's Second Interim Report of their 'Formal investigation into the Elvington Airfield Incident, 20 September 2006' (dated 11 December 2006).

96. TG's production team consists of an Executive Producer, the Presenters (including RH), Series Producer (PD), Script Producer, Director, Assistant Producer (GW) and other support as required. PD joined the team in March 2006.

97. PD was working on his first series and had responsibility for generating the short film scenarios (usually 4 per show) around which each programme is made. PD completed, dated (14/9/06) and signed the Programme Risk Assessment (PRA) for the proposed film shoot at Elvington. It was submitted to and discussed with Jon Ling on 18 September. Simultaneously, BC (Precision Driving Consultant) met with PTLE's Team Principals at their

base in Northampton. He generated a briefing note for RH and the Top Gear team in which he described 'Vampire', how it should feel when driven and use of the 'afterburner'.

98. The Director of Occupational Risk Management (ORM) at the BBC is Jim Brown. Their website (<http://hss.gateway.bbc.co.uk/>) states that 'ORM advises on occupational health, safety, security and environmental issues affecting the BBC. ORM has specialists on call 24 hours a day for urgent operational enquiries and to respond to emergencies'.

99. Jon Ling (JL) was the principal contact in ORM for the 'Factual and Learning' production arm of the BBC that was responsible for Top Gear. It was not routine that all PRAs should be referred to ORM but BBC Insurance contacted ORM on 14 September drawing ORM's attention to the jet car film shoot. Jon Ling and PD discussed the shoot in general terms on 18 September and Jon Ling's additional notes were added verbatim to the PRA. They were as follows:

*'If shoot being cut to one day, ensure Hammond's training adequate and no corners cut.
Keep speed to a minimum where possible and only increase to significant level (the company will know when the risk increases significantly).
Who has final say if shoot goes ahead e.g. adverse weather etc.
Ensure no staff put at risk if vehicle goes out of control e.g. positioning of cameraman.
Ensure Hammond not distracted by PTC's (pieces to camera) – need strict adherence to this
Track checked over before each attempt as per RA
Access to medical facilities – if it all goes tits up, can we get him out of there fast and to adequate facilities?
Ensure no pressure on presenter if not happy'.*

PTLE

100. This part of the report is based on interviews with PTLE's Team Principals on 9 October, their cooperation in meetings relevant to the technical examinations carried out by NYP and the Transport Research Laboratory and PTLE's response to HSE's letter of 27 September 2007 (see above).

101. Their evidence is that PTLE is a partnership formed in 1994 and controlled by CF and MN. It has no direct employees and relies on support from family members, Malcolm Pittwood (Engineering Consultant) and volunteers. Their H&S Policy statement (dated 6 June 2006) states that it operates '*high powered and jet powered vehicles*' and their aim is to '*maintain the safety of drivers, team members, track officials, volunteers and the public during events it attends which are promoted and/or organised by others*'. The Team Principals are jointly responsible for the safe conduct and operation of all (3) of their vehicles. CF is responsible for engineering. MN is the fundraiser and Team Manager.

102. In response to HSE's request for PTLE's risk assessment for the Top Gear film shoot, PTLE submitted a document produced in March 2006 for a land speed record attempt on the main runway at RAF Fairford, Gloucestershire. Section 5 of this document (Health and Safety: Hazards and Risk Assessment) had been copied to the BBC who received it on 14 September. As such the risk assessment that PTLE relied upon was not specific to the film shoot on 20 September and the 'activities' that it addressed did not include the training for RH in his use of *Vampire*.

RELEVANT LEGAL REQUIREMENTS

BBC

Management of Health and Safety at Work Regulations 1999 (**MHSW Regs**)
Regulation 3(1)

Personal Protective Equipment at Work Regulations 1992 (**PPE Regs**) Regulation
4(1)

Health and Safety at Work etc Act 1974 (**HSWA**) Sections 2(1) & 3(1)

PTLE

MHSW Regs Reg 3(1)

Provision and Use of Work Equipment Regulations 1998 (**PUWE Regs**) Reg 4(1),
5(1), 8(1) and 9(1)

HSWA Sec 3(1)

EFFECTIVENESS of PREVENTIVE MEASURES - taken by dutyholder(s)

1. The fact that RH survived this well publicised, spectacular crash owed much to:
 - i. The professionalism and speed of response of the on and off-site paramedic and fire and rescue services (namely, Inter County Paramedics, Event Fire Services and Yorkshire Air Ambulance) and the treatment that RH received in the neurological unit at Leeds General Infirmary. The BBC in liaison with PTLE had commissioned on-site provision.
 - ii. The design integrity of *Vampire*. This was endorsed, as follows in the NYP Collision Investigation Report, '*damage to the car was remarkably light; this is testimony to the extremely strong construction of the vehicle. The cockpit area of the car had remained completely intact and there was no intrusion from any of the bodywork or other components*'.
 - iii. The 5-point harness used to secure RH in the cockpit, and
 - iv. The personal protective equipment (and in particular the driver's helmet) that he was wearing.

COMMENTARY - on adequacy of health and safety management

BBC

2. In 2003 HSE's Lead Inspector for the BBC (Bill Hazelton, HM Principal Inspector) assessed key aspects of the BBC's health and safety management system with reference to the model in HSG 65, 'Successful Health and Safety Management'. This intervention involved a review of documents, workplace inspections and interviews with management, staff and trade union representatives in a number of departments.

3. Bill Hazelton submitted a report of his findings to the BBC in November 2003. It set out a number of 'broad themes' and action points. Some of these 'actions', which were specifically advised to improve organisational arrangements and planning for health and safety, are relevant to this investigation.

4. At HSE's visit to Wood Lane on 7 & 8 November 2006, Jon Ling (Principal Risk Manager) described some of the work that the BBC had been doing to implement HSE's recommendations. However, additional and new lessons have emerged from the accident at Elvington. The BBC's internal investigation report, which has been disclosed to HSE, addresses these points.

PTLE

5. PTLE is an '**event**' based organisation and its safety policy statement (updated in June 2006) makes the following commitment '*it is the aim of PTLE to maintain the safety of drivers, team members, track officials, volunteers and the public during **events** it organises or at **events** it attends which are promoted and / or organised by others*'.

6. In the circumstances of this accident PTLE took on the role of 'service provider' to the BBC and RH. The scope of this service involved provision of 'Jet Cars, Jet Fuel, Crew, Track Safety Manager (i.e. Malcolm Pittwood) and Road Transportation'; and (although not specified) it also included jet car training for RH.

7. The risk assessment that PTLE submitted to the BBC was not specific to activities and services provided at Elvington. Indeed the risk assessment was simply 'lifted' from PTLE's 'Safety Submission and Risk Assessment' for their speed record attempts at RAF Fairford in July 2006. The extract had not been adapted to address RH's training although it did specify the following control measures for the tyres i.e. '*track is FOD (free of debris) before each attempt, to remove any items that could cause puncture*' and '*new high speed Land speed tyres are in use*'!

VIEWS of THOSE AFFECTED

Richard Hammond (RH)

8. RH who was interviewed in Bristol was remarkably sanguine about the whole affair. He had been very keen to do the feature in the first place, and had obviously been enjoying it on the day. He had been very keen to go for the final run.

9. He seemed satisfied with the standard of training provided by PTLE. It was very much '*hands-on*' and '*sitting with Nelly*', but he felt that, given the timescale, he derived more benefit from this than he would have from reading a training manual.

10. He made the point that he has done a wide range of events and stunts and that he is very good at taking instruction on-board. He has driven a wide range of high performance cars and motorcycles and is familiar with high performance driving techniques such as left foot braking. He had recently completed a two-day feature with the Renault Formula 1 racing team. This had involved him driving two lesser formula cars and finally the current Renault Formula 1 car on a racing circuit. In many respects this was probably a much more complex task than driving *Vampire*.

11. This broad experience made him very adaptable, He says that he is '*no fool*', and he has in the past walked away from stunts that he thought were too dangerous or when he thought that he was dealing with people who did not know what they were doing. He had been impressed by the competence and thoroughness of PTLE.

12. He realised that there were lessons to be learned from this incident. Some things had been done very well; others could have been done better. He would be happy to help the BBC to use the Elvington accident as a training example.

BBC

13. The BBC fully cooperated with the HSE investigation. They also launched their own internal investigation. This has identified that some things had been done very well, mainly because of the experience of the Top Gear team.

14. A risk assessment had been carried out, but this had not involved the Operational Risk Management team until very late in the proceedings.

15. The risk assessment process had not adequately addressed RH's training. They had accepted the risk assessment that PTLE had submitted for their record attempt at Fairford, and this did not cover training.

16. The BBC has recently launched a new network based risk assessment system which was intended to enable programme makers quick access to best practice solutions. The Top Gear accident will be used to promote this system.

PTLE

17. The meeting with PTLE at Northampton was quite productive. It quickly became evident that CF was a consummate jet propulsion engineer, and that his knowledge of *Vampire*, and of the UK jet car scene was encyclopaedic. MN was a very experienced driver and handled the business end of the partnership.

18 PTLE have failed to provide any meaningful documentary evidence about the history of the tyres fitted to Vampire, and in particular the fact that the rear tyres were 5 years old.

19. PTLE directed HSE to their supplier, Hauser Racing, and it is they who provided HSE with details of the tyres from '*Hoosier Racing Tire Corp*', which Hauser had supplied to PTLE in the last 2 or 3 years. Hauser do not keep any tyres of this type in stock, they had simply acted as a local agent for Hoosier and had passed the tyres supplied to them by Hoosier directly on to PTLE.

CONCLUSIONS and LESSONS for the BBC and PTLE

For the BBC

20. We have read the BBC's internal investigation report of the accident at Elvington. The lessons, which they have identified, have been linked to a 5-stage model, which they propose to manage the risks arising from programme making. Their model is a 'control loop' and the 20 actions, which include 8 priority recommendations, address the main failings that we have identified in our investigation.

21. We have concluded that, with regard to the film shoot at Elvington the BBC failed to:

1. Allow sufficient time for planning, preparation and consultation.
2. Make full and appropriate use of in-house support (ORM) and external technical resource (BC)
3. Ensure that the 'services' requested from PTLE were clearly and fully communicated to them.
4. Challenge PTLE about the adequacy of the Risk Assessment, which they submitted for the film shoot.
5. Ensure appropriate exchange of information regarding risk assessments between themselves and PTLE.

6. Request relevant third-party assurance from PTLE about the 'fitness for purpose' of the work equipment that they supplied.
7. Ensure that RH's training needs for his safe use of *Vampire* were clearly specified and appropriately delivered before and during the film shoot at Elvington.
8. Ensure by effective monitoring that the onsite safety checks and controls for which PTLE were responsible were clearly specified and carried out.

Recommendation

We acknowledge that the BBC's internal investigation has identified appropriate actions and recommend that a plan should be formulated to implement these measures to improve the BBC's current arrangements for the managing health and safety in programme making.

For PTLE

22. PTLE operate at the extreme end of the automotive spectrum. The principals are driven by the desire to achieve extreme speeds in the pursuance of land speed records. Like all expert participants in extreme activities, their motivation allows them to accept a shift in the normal risk equation balance point towards the higher risk end.

23. Travelling along the ground at 300 mph is an inherently dangerous activity because of the kinetic energy involved in the moving vehicle. If a critical part of the vehicle fails, or if control is lost for any reason, then any accident arising is likely to be a big one.

24. The principals are very aware of these dangers. In the normal course of events, it is they who are exposed to any risks arising from their activities. They mitigate the risks by using a purpose-built vehicle that incorporates aeronautical equipment and practices for its propulsion, and that draws on drag racing practices for the automotive parts of the vehicle. They also have confidence in their own technical and driving expertise and rely on their many years of experience of driving such vehicles to ensure a safe outcome.

25. PTLE state that over the years they have undertaken approximately 3000 high-speed runs in *Vampire* without any significant accident arising. This is a very commendable record.

i. Selection and use of tyres

26. It is essential that PTLE maximise the margin of safety on their safety critical equipment. In particular, where a safety-critical component is liable to deteriorate with age it should be replaced before any such deterioration can significantly affect the component's performance. This "service life" approach is well established in aeronautical practice, where critical components cannot be allowed to fail in service, and should be very familiar to PTLEs principals.

27. The choice of the Hoosier tyres fitted to *Vampire* has come under close scrutiny because they are made for sports car racing not for ultra-high speed sprints / record attempts.

28. PTLE state that they originally chose the tyres based on the experience of other teams operating similar vehicles. The tyres have very stiff sidewalls, which made them suitable for travelling very fast in a straight line. (This stiffness could, however, mask a loss of tyre

pressure in the event of a slow puncture). They have been using the tyres for approximately 12 years without incident and this proven track record cannot be denied.

29. The Transport Research Laboratory Report concludes that the front offside tyre '*burst as a result of an object (or possibly objects) having entered the sidewall immediately adjacent to the edge of the tread*'. The author did not consider that '*deterioration owing to age was a significant factor in the tyre having burst*' and he also concluded that '*none of the other tyres showed any signs of damage, other than wear from hard use and abrasion from the car having slewed sideways as it left the runway*'. The BBC's consultant who also examined the tyres came to similar conclusions.

30. Both experts have been critical of the fact that the tyres fitted to the rear of Vampire were 5 years old. Hoosier recommends that competition tyres should be used within 2 years. More generally, a maximum tyre shelf life of 6 years is often quoted for road tyres.

Recommendation

31. Although the age of the tyres was not found to have been a factor in this accident: as a matter of principle, **it is considered that PTLE should not use tyres for high speed runs that exceed the manufacturers recommended age limit of 2 years. In particular they should not fit tyres older than 2 years when third parties are to drive their jet cars and extreme vehicles.**

ii. Risk assessment

32. The risk balance equation changes when third parties such as RH are allowed to drive PTLE's jet cars. Anyone volunteering to drive *Vampire* is likely to be strongly motivated by speed; it is not an activity that one would normally undertake out of academic interest. Effective training is essential to ensure that the driver is given the necessary knowledge, skills and practice before high-speed runs are attempted. Foolhardiness and a 'gung ho' attitude is no substitute for practiced competence

33. In the context of the Elvington event the risk assessment submitted by PTLE and accepted by the BBC is not considered to have been suitable and sufficient because it was not site-specific and made no allowance for the training of a non-expert, third party driver.

Recommendation

34. **PTLE's risk assessments for use of their jet cars and extreme vehicles should always be suitable and sufficient. Generic material may be used, but site and event specific factors and the experience of drivers should always be adequately addressed.**

iii. Third-party Training Programme

35. Both RH and Colin Goodwin, who drove Vampire in 2001, have said that the practical and hands-on training provided by PTLE was very good.

36. From an HSE and occupational perspective the training was immediate, practical and hands-on. However, PTLE did not attempt to formalise and assess RH's training needs beforehand. This raised a number of relevant concerns:

- i. How could the quality and content of a training programme be assessed before the event without any supporting documentation?
- ii. How could the participants do any pre-event preparation?
- iii. How could progress with the programme be monitored and competence assessed?
- iv. And (as in this case) if an accident happens, how could PTLE justify what they had done?

37. HSE's ergonomics expert has questioned the training provided to RH. Although *Vampire* behaved like a car some of its controls were very different from those in a conventional vehicle. His report concludes that *'the training available to Richard Hammond would have familiarised him with the working of the car but would not have allowed him to build up the skills which he could readily employ in the event of an emergency'*.

38. RH was clearly adept, and his long experience of high-speed driving meant that he was not likely to be overwhelmed by the whole experience. However, if something went disastrously wrong (as it did) he would have to respond immediately and unconventionally and would not be expected to use conditioned reflexes. A reasoned response would take longer and the lost time could have a critical effect on the final outcome.

Recommendations

39. PTLE should review their decision to allow third parties to drive their jet cars and extreme vehicles; and if this is to continue a fully documented training programme should be drawn up to ensure that persons allowed to drive PTLE's jet cars and extreme vehicles are competent.

40. Some key learning points for broadcast industry have been raised in Mike Gray's ergonomics report. **HSE's investigation team undertake to refer Mr Gray's opinions to the Joint Advisory Committee for Entertainment, for further consideration.**

ACTION PROPOSED

41. Separate meetings are proposed with the BBC and PTLE to confirm the conclusions of HSE's investigation. Our conclusions will be confirmed verbally and in writing and both parties will be sent a copy of the TRL 'Tyre Failure Report'. These meetings will involve, if convenient, a representative of NY Police and the review meeting with the BBC will be arranged to involve Bill Hazleton.

42. A letter will be sent to RH to confirm our conclusions and he will also be sent a copy of the TRL Report.