NYC08FA023

HISTORY OF FLIGHT

On November 2, 2007, at 0832 eastern daylight time, an experimental amateur-built Vans RV-10, N289DT, was substantially damaged when it impacted terrain near Greenville, Pennsylvania. The private pilot/builder was fatally injured. Day visual meteorological conditions prevailed for the local flight that departed Greenville Municipal Airport (4G1), Greenville, Pennsylvania. No flight plan was filed for the personal flight conducted under 14 Code of Federal Regulations (CFR) Part 91.

According to a family member, the pilot had driven to the airport to practice "touch and go's" and to make sure everything was functioning properly, prior to a planned afternoon trip in the airplane with his family to Boston, Massachusetts.

Witness interviews were conducted by the Federal Aviation Administration (FAA) and the Safety Board, and while no one saw the airplane depart 4G1, the airplane was observed by a witness at approximately 0800 traveling in a northwesterly direction at low altitude, moving "fast" and sounding like it was "running strong like a Ford Mustang (turbocharged) Cobra that the witness once owned." At approximately 0825, the airplane was again observed; this time by multiple witnesses. Descriptions varied between witness statements as to the altitude, direction of flight, and velocity of the airplane; however, the preponderance of witness statements were that the airplane was flying north on the east side of Pennsylvania State Route 58, and seemed to make a circle to the left at approximately 500 feet above ground level (agl). It was next observed to travel in a westerly direction, fly across Route 58 and make another turn to the left with the engine "revving up and down" and losing altitude. When it reached approximately 50-feet agl, heading east, the airplane rolled wings level and impacted a cornfield and a fireball erupted.

PERSONNEL INFORMATION

The pilot held a private pilot certificate, with a rating for airplane single engine land. His most recent FAA third class medical certificate was issued on March 14, 2006. According to his pilot logbook, he had accrued 221.4 total hours of flight experience.

AIRCRAFT INFORMATION

The experimental amateur-built airplane, was a four place, low wing monoplane. It was equipped with a non-certificated Eggenfellner E6T/220, water cooled, fuel injected, turbo-charged, 220 horsepower, six cylinder engine. The airplane's special airworthiness certificate was issued on July 10, 2007.

METEOROLOGICAL INFORMATION

A weather observation taken about 23 minutes after the accident at Port Meadville Airport (GKJ), Meadville, Pennsylvania, located about 14 nautical miles northeast of the accident site, recorded the winds as 090 degrees at 4 knots, visibility 10 miles, sky clear, temperature 1 degree Celsius, dew point -2 degrees Celsius, and an altimeter setting of 30.36 inches of mercury.

WRECKAGE AND IMPACT INFORMATION

Examination of the accident site by an FAA inspector revealed that a post impact fire had ensued. The airplane had come to rest inverted on route 58. Further examination of the accident site revealed that the airplane had impacted in a 35 to 60 degree nose down attitude. An approximately 100-foot debris path extended from the point of impact in the cornfield to the shoulder of Route 58.

The left wing was bent aft at the root with evidence of aft bending along the length of the wing panel. The right wing exhibited compression damage in an aft direction from the wingtip inboard, for approximately one third of its length. The empennage was intact but was partially separated from the fuselage just aft of the rear window location, lying forward of the left wing tip, and was found inverted from its normal mounting position.

The engine and firewall were separated from the fuselage and the majority of the hoses and belts had been consumed or were heavily fire damaged. Three of the four composite propeller blades were found at the initial impact point and one was found under the main wreckage.

Post recovery examination of the wreckage by the National Transportation Safety Board revealed no evidence of any preimpact failures of the airframe. The doors were closed and latched during the impact sequence, the structure had experienced heavy impact damage and tumbling, and the upper and lower baggage bulkheads were missing.

Engine Examination

Examination of the engine, and propeller speed reduction unit (PSRU), revealed no evidence of any preimpact mechanical malfunctions. Both engine timing chains were intact, the crankshaft was rotated by hand, and drive train continuity was confirmed. The PSRU contained oil, and rotated freely. Compression was obtained on all cylinders. Oil was present throughout the lubrication system. The intake and exhaust systems were compromised and exhibited breaks in the tubing. The turbocharger waste gate was closed and the turbocharger could be rotated by hand. All of the sparkplugs were intact.

Propeller System Examination

The airplane was equipped with a 4-blade, in-flight adjustable, constant speed propeller. It consisted of an electric variable pitch hub manufactured by Quinti Avio, which was mated to the composite propeller blades manufactured by Sensenich.

Examination of the propeller hub and the remains of the propeller blades revealed no evidence of preimpact mechanical malfunction. Further examination of the propeller assembly revealed that the four composite propeller blades were separated at the 4-inch blade radius station, which corresponded to the positions of the hub barrel clamps.

Examinations of the blade surfaces indicated that the blades were not in rotation at time of impact. The electric pitch control motor end bell and exterior nylon slide exhibited severe melting. The blade retention nuts were also found tightened approximately 1/4 inch tighter than the index marks scribed on the hub. This however, did not appear to affect the pitch rotation friction. Disassembly of the propeller hub revealed that the pitch motor gearbox was intact and immobile, (as designed) and held the last pitch angle selected when under no electrical load. Examination of the blade shank assemblies, bearings, and pitch slide assembly revealed no anomalies, and measurements of the propeller pitch setting corresponded to a high pitch (cruise) setting.

Examination of the propeller control

Examination of the propeller controller revealed that it was not the propeller controller that was manufactured by the propeller manufacturer. Instead, a manual electric pitch change system had been installed that consisted of a double pole panel mounted switch that could change the polarity to the electric hub motor. The motor could either run clockwise or counterclockwise from fine to coarse pitch. It was

incapable of monitoring propeller rpm, and could not maintain the propeller at a constant speed by automatically varying blade pitch angle.

Fuel System Examination

Examination of the fuel system revealed that all fuel filler caps were closed and latched and the fuel selector valve was in the right fuel tank position.

Instrument Panel Examination

Examination of the instrument panel revealed that the airplane was equipped with a dual screen Chelton Flight Systems Electronic Flight Information System (EFIS), A Dynon Avionics D10A backup EFIS, Dual Garmin SL-30 navigation and communication radios, a Garmin 496 Global Positioning System (GPS), and a Grand Rapids Technologies Engine Information System (EIS) monitor.

Further examination revealed that the panel switches were positioned for flight. The "X-TIE" switch was in the off position, The "FUEL" switch was in the "ON" position, the "IGNITION" switch was in the "ON" position, the "FUEL SELECTOR" (electric fuel pumps) switch was in the "MAIN" position, and the "BUSS SELECTOR" switch was in the "ON/MAIN" position.

Flight Control System Examination

Examination of the flight control system revealed no evidence of any preimpact failures. Control continuity was established from the ailerons, elevator, and rudder, to the breaks in the system, which displayed evidence of tensile overload.

Further examination of the flight control system revealed that, the outboard ends of the ailerons had been filled with foam and then fiberglass had been used to seal in the foam. A trim tab for the rudder was discovered to be attached with duct tape. The lock nuts which were used on the rod ends for the pitch control system could be spun by hand and were not tightened against the rod ends, and were found on the threaded portion of the rods approximately 1/4 inch away from what would be their normal seated positions. The right trim tab rod on the elevator was connected to its rod end by two threads and was shorter than the trim tab rod for the left trim tab. It displayed evidence that the end of the trim tab rod at one time had broken off, and then had been re-inserted into the rod end, as the rest of the threaded portion was not present.

Electrical System Examination

The remains of the batteries and contactor relays were located in the center tunnel area of the cabin.

Examination of the remains of the electrical system revealed that the batteries and contactor relays had been exposed to the post impact fire.

Multiple wires showed no evidence of having being connected prior to impact. Examination of the cableing connected to the electrical system's contactor relays, revealed that a cable was not secured to its corresponding terminal on the contactor relay.

Further examination revealed that the terminal bore no evidence of dimpling or indentation and its interior surface was sooted.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot by the Office of the County Coroner, Mercer County, Pennsylvania. The cause of death was attributed to multiple blunt trauma.

Toxicological testing of the pilot was conducted at the FAA Bioaeronautical Sciences Research Laboratory, Oklahoma City, Oklahoma. The tests were positive for ibuprohen.

TESTS AND RESEARCH

Global Positioning System Data

Information downloaded from the airplane's Global Positioning System (GPS)unit revealed that a tracklog for the accident flight had been recorded. Based on GPS groundspeed and altitude, the accident airplane took off from 4G1 at approximately 0812 edt. The airplane than manuevered in the area surrounding the airport. It landed at 4G1 at 0825 edt and departed again at 0827. It than climbed to an altitude of 2,400 feet GPS altitude, and reached a groundspeed of 152 knots before descending in a left hand spiral above Pennsylvania State Route 58. The final tracklog point was located just west of the roadway. The last recorded GPS groundspeed was 71 knots, the last reported heading was 118.7 degrees, and the last recorded GPS altitude was 1,366 feet.

Engine Builder Information

According to the engine builder, unlike "older engines" which used carburetors, magnetos, and mechanical fuel pumps, the engine required a constant and stable source of electricity to operate the fuel injection, fuel pumps, and engine control computer.

The pilot had installed a fuel filter on the upper pilot side of the firewall prior to the engine being installed. During the installation, the pilot discovered that the filter would not clear one of the diagonal engine mounting tubes, providing the main support for the nose wheel, and removed it. Rather than relocate the filter to another location, the fuel feed line, from the high-pressure fuel pumps, was run through a nylon grommet in the firewall. This penetration, as well as the fuel return line, was at the front of the center tunnel.

The battery and contactor relay location was on top of the high-pressure fuel pumps and next to where the fuel feed line and fuel return line came through the firewall.

Instrument Panel Builder Information

According to the instrument panel builder, The EFIS alarm levels had not been set up by the pilot for his specific engine installation and degradation of performance in the EIS had also occurred, as the pilot had not calibrated the "PR" (Pulses per revolution) for RPM, The "K Factor" (Scaling factor) for fuel flow, and The Fuel Level Calibration. This would have resulted in erroneous readings for rpm, fuel flow, fuel quantity, and multiple nuisance alarms.

Examination of Recovered Logbooks

During examination of the wreckage, the remains of the accident pilot's logbook and the airplane's maintenance logbook were recovered.

Examination of the pilot's logbook revealed no evidence of the training required by the FAA for operation of an airplane with an engine of more than 200 horsepower.

Examination of the airplane's maintenance logbook revealed that on July 10, 2007, the FAA issued a special

airworthiness certificate allowing operation of the airplane.

Seven days later, on July 17, 2007, the pilot certified in the maintenance logbook that the prescribed 40 hours of test flying required by the FAA had been completed however, no record of separate entries for each of the test flights was discovered. The pilot also certified on that date that the airplane was controllable throughout its normal range of speeds and maneuvers, and that it had no hazardous characteristics or design flaws and that it was safe for operation. The pilot additionally certified that he had demonstrated by flight test, the operating data for the airplane and the weight and balance data.

No maintenance entries regarding removal or installation of equipment, or repair or alteration of the airplane or engine subsequent to the date of the issuance of the special airworthiness certificate were discovered.

FAA Airworthiness Records

A review of FAA airworthiness records revealed that the pilot was only authorized to operate the airplane for the first 40 hours within an area around 4G1, including a corridor to Harry Clever Field Airport (PHD), New Philadelphia, Ohio. During this 40 hours, he was to remain clear of densely populated areas and congested airways, and during the flight testing phase, no person should have been carried in the airplane during flight, unless that person was essential to the purpose of the flight.

Review of the FAA airworthiness records also revealed that the weight and balance data supplied to the FAA differed from the weight and balance information in the airplane's maintenance logbook. These differences included differing centers of gravity and a difference in empty weight.

Witness Statements and Interview Summaries

During the course of the investigation the Safety Board conducted a series of interviews, and reviewed witness statements, photographs, and emails. The following is a summary of the information obtained.

According to friends and other builders, the pilot was impatient with the time it was taking to do everything, and he was pushing to get the airplane assembled and flying in time for the Experimental Aircraft Association (EAA) convention at Wittman Regional Airport, (OSH) Oshkosh, Wisconsin. This resulted in the pilot doing such things as requesting the instrument panel builder to send the panel "as quickly as possible," and traveling to the engine builder's facility to pick up the engine instead of waiting for shipment.

On July 12, 2007, the airplane's first flight occurred with Clecos (temporary fasteners) holding the upper aft portion of the cowling in place and with a passenger onboard. Total duration of the flight was 40 minutes.

On July 13, 2007 the pilot emailed an RV builders group that he was a member of stating that, he had 39 hours and 20 minutes left to fly off, and that if he "followed the plan" he would "make it with a little to spare," and thought that he would complete the 40 hours of test flying and make it to OSH for the convention.

On that day, the pilot added approximately another 1.5 hours flight time towards the 40-hours but the engine experienced some high oil temperatures so the pilot decided to fly the airplane down to the engine builder's facility at Massey Ranch Airpark (X50), New Smyrna Beach, Florida

On July 14, 2007, the pilot and the engine builder departed 4G1 for X50.

On the trip to Florida, they experienced the high oil temperatures, and experienced slower than anticipated cruise speeds of less than 140 knots. They also experienced vibrations that they were unsure of the origin of.

During the trip, the pilot contacted a friend and asked him how to disable "Bitching Betty." The pilot complained that the aural alarms were annoying him, and wanted to know how to silence all of them. The friend advised him that once the pilot finished calibrating his EFIS and alarm set points during his test flights, they would be in the green most of the time, and that he would not be bothered so much as the alarms would only go off when out of the specified green range. The friend also advised him that it was up to him to set the proper ranges, and to make sure his sensors were setup and calibrated properly, so the readings were correct. He also advised him that once he did all that, he should not receive many false alarms. It was at this point that the pilot's friend realized that the pilot had never calibrated any of his avionics, so the headings were off, the engine alarms were being triggered all of the time, that he had no pitot test, and that he was having issues with choosing to display propeller rpm or engine rpm.

A transponder was also inoperative part of the time, and since neither of the EFIS systems were working, as they had not been calibrated, they had to navigate to X50 utilizing a handheld GPS. They had decided just to plug their headsets in using some alternative method to avoid having to listen to alarms, and had to swap plugs to make radio calls as the push to talk switch had been broken off of the pilot's control stick. The autopilot was also non-operational as it had not been connected to the pitot static system, and the rpm and manifold pressure readouts were inaccurate due to installation of the wrong sensor and entry of the wrong scaling factor.

Sometime prior to July 19, 2007, one of the pilot's friends learned that the pilot had not correctly completed the weight and balance on the airplane, and that he had used his friend's weight and balance data from his RV-10 and had modified it to be roughly what he believed his plane's weight and center of gravity would be. The pilot's friend thought that this was entirely ridiculous, especially after the pilot told him how much lighter his engine installation and propeller would be. As a result, on July 19, 2007 the pilot's friend posted a message on an RV builders forum, trying to urge the pilot to tell people how his weight and balance had turned out. He later learned that on the flight to X50, the pilot became aware, that his center of gravity was too far aft, and decided to eventually move the battery forward.

The friend later learned that the pilot was also disappointed in the airplane's cruise speed on the trip and that the pilot had expected "much more" from the engine and the 4-bladed propeller.

When the pilot flew the airplane to OSH, he did so with 2 blades of the 4-bladed propeller removed. The engine was planned to be turbocharged, but the turbocharger had not been completed, so prior to the flight to the OSH and while the airplane was still in Florida, they flew the airplane for all of the preliminary flights, and for many weeks after, without the turbocharger. Then on the trip to OSH from X50, he had a failure of a bracket that suddenly caused high oil temperatures, which grounded him in Kentucky until he could get some parts to fabricate a new bracket at a local store.

At OSH the pilot claimed that he had approximately 48 hours on the airplane. They removed the cowling during the show because they had made many cowling modifications to try to increase cooling which resulted in areas of unfinished fiberglass on the edges. He and the engine builder then displayed the airplane and engine and tried to attract buyers for the engine package. When one other builder stated to the pilot that "There's no way you could have completed your fly off yet." The pilot's response was "That's not what the logbooks say."

After OSH, they wanted to do some more work on the airplane so instead of heading to Pennsylvania; the airplane was flown back to X50 for the work. The airplane stayed at X50 until sometime in mid-October, 2007. During this time, they did cowling development work and installed a cowl flap to try and fix the cooling problems, and clean up the cosmetics. The temperatures were lower with the redesigned cowl and cowl flap. Towards the very end of the work in Florida, the turbocharger was finally ready, so they installed it. They took it up to 14,000 feet above mean sea level and compared the performance of the airplane to a set of

performance numbers that had been produced during a series of flights with Lycoming engine equipped RV-10s. In the process of getting their performance numbers, the turbocharger, was damaged so the failed unit was replaced.

When they did their performance tests, they took photographs of the Chelton EFIS installation as proof of the airplane's performance but, the photos also captured evidence that the Attitude and Heading Reference System (AHRS) was not calibrated, it was set up to display information from a Strike Finder digital lightning detection unit though the pilot did not have one installed, the heading was off by approximately 30 degrees, the skid indicator on the primary flight display did not agree with the skid indicator displayed on the Dynon D10A, and the ENGINE and AUX SENSOR alarm messages were being displayed.

Around October 10, 2007 some performance numbers for the airplane were posted on the Internet, and somewhere around this date a video was posted on the Internet, which showed the pilot and a friend departing X50 for 4G1.

The pilot then flew the plane up the east coast to Myrtle Beach, South Carolina. After spending the night, he and the friend flew the following day to Maryland and then to Taunton, Massachusetts where the pilot "came in long" and had to execute a go-around, during which the propeller would only develop approximately 1900 rpm. They then came back around for another landing without incident. The pilot then spent the night at his friend's "place," and the following morning flew to 4G1.

When the airplane arrived at 4G1, an airframe and powerplant mechanic observed the airplane join the downwind leg of the traffic pattern and could hear what to him sounded like the propeller was "cycling."

At one point within 2 or 3 weeks of the accident, the pilot called a friend and told him that he was having problems with power and propeller rpm control. The friend was surprised and wondered why this was happening with a constant speed propeller. The pilot advised him that it was because the engine builder had not yet finished designing the propeller control unit. He had to manually make power adjustments, which would change the engine and propeller rpm greatly. With the propeller now changing pitch, it would effect the propeller rpm drastically, and he would then have to manually move a prop pitch lever to bring the propeller rpm to its desired setting. As a result, every power increase or power reduction required a corresponding adjustment of the propeller.

Also in the last few weeks before the accident the pilot emailed him that he thought his Chelton EFIS wasn't displaying correctly. He said he had indicated 2300 Gs (G-forces) when flying with his wife, and emailed him a photograph of the display.

It was later revealed, that the pilot was reading "2300G" which meant the airplane was at 2,300 feet above ground level based on GPS altitude. His friend then realized that the pilot had never really read through any of the operations manuals for his avionics. The pilot had also previously complained that on his trip to X50 his autopilot didn't work, and criticized an avionics dealer for not telling him that he had to connect the pitot and static lines to his autopilot, though it was listed in the manual as part of the installation procedures for the autopilot.

On October 25, 2007, he emailed his friend and stated:

"Eww I am an idiot!! I had no clue because yesterday I was at 6000ft and it did the same thing, listing 2330 g's with the same reading, and then tumbled to the right. I am scared of it and that is why I have not been using it. It is difficult for me to process everything it is telling me. I can understand some of it, but then it starts putting up all this other stuff and it is just easier for me to look out the window for now. But I do need to learn it so I can feel comfortable before I ask an instructor to fly with me. I called .... and he said it is because

I have not calibrated it, for that matter this is the first couple of times I have turned it on for anything. So yes I need to read the manuals and build many hours using it before I get in the clouds. I need a lot of help to learn all of this stuff because I am not having a clue on how to do it. Definitely a case of money versus intelligence. But I have to learn it to use it. Does that mean I can come up and get some lessons? Or do you know anyone who will teach behind it? I have been using the Dynon and G496 because they are easy. Everything else is still uncalibrated, including the AP etc. I am definitely behind the power curve on this and need help! And they say that is the first step to recovery, realizing that there is an issue and asking for help!"

His friend once again advised him that he really needed to "read the manuals," and offered suggestions regarding training.

The pilot followed up with another reply:

"I just got off the phone with .... and he said it is like trying to drink from a fire hose, and I tend to agree. I need to get my hands around flying the airplane and getting everything calibrated. Then I can sit down and read the complete manuals. I have read the first 4 chapters of the Chelton manuals but that is just basic symbology and the tapes, and those I do understand. If you take all of my owners manuals and stack them up they are over 3 feet high! I am lucky the dynon and 496 are already familiar because I can use them to navigate and get myself out of trouble if absolutely necessary. Remember I have only flown a Cherokee 140 for 200 hours, so I am learning how to fly high perf stuff too, I feel more comfortable, but still learning the Egg stuff/ and the variable pitch prop is also more stuff to learn. I am getting there and in a couple of hundred more hours I will maybe be ready to start IFR training again. I have passed the written, and have 10 hours towards it, but with the new plane I can already tell it will be time to start over. Right now I am working on how to slow down and make sure I have enough pitch on the prop for a go around, once that is done, I will move up the ladder a rung and work on additional stuff. Calibration, troubleshooting other electronics etc is also going on at the same time ...and you both say I have to just laugh at myself and the various issues I am having because everyone has something or another happen. But it just seems like lately I am way out of my comfort zone and clawing my way back in."

His friend replied in part that:

"No prob. You're right, there's a lot of stuff there to learn even without the avionics... The -10 is high performance, slippery, and there's a LOT going on with the C/S prop and engine stuff.

I would encourage you to calibrate a.s.a.p. because you really will be hindered in improving skills and having the experience go well until that's done. Things like Bitchin' betty are there for a reason, and just flying without them will not add to the safety. It would be better to HAVE the warnings when they happen, but have them happen appropriately. None of it is that hard to set up, but it all takes time.

I flew 70-100 hours before I did anything other than normal stuff for the most part. Just take your time."

On November 1, 2007, the day before the accident, the pilot once again emailed his friend asking:

"What speeds do you carry on base and final when at max load? I am taking the family on our first trip and I am being paranoid but this is the first time I have taken more than 1 passenger. So just doing due diligence."

His friend replied back advising what airspeeds he used, and the pilot replied back to him that:

"Good that has been what I have been flying, but I float awhile and was thinking I was carrying to much speed because .... had us carry 70 mph on final, and since I switched to knots I was thinking that was my issue, but until I get allot more comfortable I will bleed the speed over the runway, instead of slowing on the

approach, much safer in my mind! Going to the airport to redo W&B after I moved the batteries forward, then I get to fly this afternoon and tomorrow to get ready to take the family to Boston on Saturday! THX for being there for questions, it is always good to have a friend that can double check my thoughts."

At approximately 2300 another friend also spoke with him. The pilot advised him that he had determined that the weight and balance was wrong and had moved the batteries forward but the battery cables were also wrong and he did not have a battery terminal crimping tool, and was using a big set of channel locks to crimp with."

ADDITIONAL INFORMATION

FAA Guidance

According to the FAA, after an FAA inspector inspects an amateur built airplane, the inspector will issue a set of operating limitations. Those limitations then become regulations for operation of the airplane and are part of the special airworthiness certificate. The airworthiness certificate that is issued at the time of the inspection contains two phases. Phase 1 is the initial flight testing phase of the aircraft, and Phase 2 lists the operating limitations that go into effect upon completion of the flight testing. Phase 2 applies for the duration of the certificate.

14 CFR Part 91.305 defines a flight test area and states that flight testing must occur over sparsely populated areas having light air traffic.

14 CFR Part 91.319 provides a listing of operating limitations. The flight test area is defined within the Phase 1 limitations along with the required number of hours that the airplane must be flown. The primary restrictions regarding flight testing are: (1) no passengers, (2) day, visual flight reference only, (3) no operation over congested areas, (4) the pilot must also advise ATC that they are experimental, and (5) the pilot must have the appropriate ratings. It also requires that in order to have the Phase 1 restrictions lifted they must prove that the aircraft has no hazardous operating characteristics and that it is controllable throughout its normal range of speeds and maneuvers.

14 CFR Part 21.93 requires that any major changes that are made to an airplane require inspection by the FAA prior to further flight.

AC 90-89A Provides guidance regarding flight testing and includes information for determining the weight and balance of the airplane.

Kit Manufacturers Guidance

As part of the kit that the pilot purchased from the airplane kit manufacturer, guidance regarding crimping of wiring was provided.

The kit manufacturer's "Finish Kit Contents" also provided guidance for determining weight and balance, as well as guidance for final inspection and flight test.

Engine Builders Guidance

Guidance was also provided by the engine builder regarding electrical connections in both the E6-Series Powerplant Installation Guide (Chapter 3: Electrical Installation) and in the Eggenfellner Subaru Electrical Systems Installation Document (Creating Good Cable Connections).

Use your browsers 'back' function to return to synopsis
Return to Query Page