



Figure 2.29 ENG truck with microwave transmit dish atop a raised pneumatic mast

The Backhaul

Selecting the Path

Assuming the event is to be transmitted live, the next issue is how the signal will get from the remote site back to the headquarter's studio. This is referred to as the backhaul. It could be by microwave, landline or satellite. At most sports venues, permanently installed landlines are available. Oftentimes a satellite path is used as a backup. If the backhaul fails and there is no backup, there is no show. Many a career has been shortened, and time stressed off people's lives because of a live show that didn't make it back to its intended location. Landlines, almost exclusively fiber, provide the best quality and are the most reliable. Often though, especially if the remote is for a local station, microwave will be used. ENG microwave trucks used for news live shots are often pressed into service to provide a path from the venue back to the station. If the venue is outside the range of the station's microwave receive sites, then a station with a satellite truck might use it to get from venue to station via a geosynchronous satellite.

Geosynchronous satellites rotate around the earth above the equator at a rate of once per day. This means that they appear to remain stationary

when viewed from the earth. Thus, once a satellite truck has correctly aimed its dish at the desired satellite, or bird as it is known, the satellite for all intents and purposes does not appear to move out of the dish's aperture. A string of satellites orbit the earth above the equator. Being not completely unaffected by the earth's atmosphere, even at 23,000 miles up, their orbit continually decays. Fuel on board the satellite is used to fire small booster rockets periodically to correct the decay. But eventually the fuel runs out, the satellite's orbit decays and the bird goes out in a brief flash of glory as it re-enters and burns up in the atmosphere. New birds are continually launched to replace the old ones that plunge back to earth. Sometimes birds die prematurely, either by leaving their orbit or simply going dark. As a result, at times there are enough satellites for all that want to use them, and sometimes there are not enough. Each satellite has a number of channels available for relaying signals. These channels are called transponders. A single satellite normally handles many separate



Figure 2.30 Microwave paths are often affected by trees and foliage that are either directly or even peripherally in the path. (Source: Tim Stoffel)



Figure 2.31 Microwave paths over water are often problematic as atmospheric conditions may refract the microwave signal and cause it to miss the receive dish.



signals at the same time.

While the majority of television stations in the United States have one or more ENG microwave trucks, a couple hundred also have Ku satellite trucks. Ku stands for the band of RF spectrum that these trucks use. Ku is preferred by most television news organizations because the equipment needed is generally smaller and less power-hungry than trucks that use the other common frequency band, the C band. Trucks that use this band are generally owned by independent vendors that cater to the satellite uplink market. These independent vendors also own Ku trucks. So our backhaul can consist of hiring a national long-haul fiber carrier such as Vyvx (division of Williams Communications), an independent satellite uplink provider, or a local television station's Ku truck. Some local broadcasters also have connections to Vyvx, known as a point of presence (POP), so it is possible to rent a station's microwave truck to get the signal back to the station, where it is handed off to Vyvx. In addition, some local stations have their own fixed C-band uplink facilities or a path to someone else's uplink facility. In that case, the ENG microwave truck could be used as a terrestrial link to a satellite uplink. As you see, between main and backup backhauls a wide combination of paths and links may have to be used.

Let's look in a little greater detail at our backhaul options.

Microwave

As shown in Figure 2.29, once the mast is raised, the microwave dish at the top is pointed towards a receive site. For a short-duration news shot, if a "line of sight" path from the truck to the receive site is not available, the truck and the corresponding steerable receive site will "fish around," pointing the transmit and receive dishes in directions other than straight at one another. Usually the receive side will point in the general direction of the truck, and the truck will pan the transmit antenna until the best signal is received. Then the receive end will do the same. This might go on for a few iterations. Often the path will end up bouncing off one or more objects, such as hills and buildings. Sometimes the receive site will find the best reception from the truck is from a direction far different than the truck's true bearing. While this usually works for the short duration of an ENG shoot setup and on-air live shot, it is not recommended if the path is required for long periods, and especially if the whole show, not just a segment in a news show, is counting on the path. A bounce path might work earlier in the day, but not later as atmospheric conditions change or buildings used to bounce the signal heat up or cool down.



Figure 2.32 Ku satellite truck receives audio and video outputs from the production truck behind it and uplinks them back to the television station, approximately a 46,000-mile trip up and back down from the satellite, whether the station is across town or across the country. (Source: Tim Stoffel)



Figure 2.33 This is a combination Ku and ENG van. Rear dish folds up and is rotated toward the desired satellite. The front mast is extended up and its mast folds up and is pointed toward a microwave receive site. (Source: Wolf Coach)



Figure 2.34 Ku truck, dish aimed and open for business (Source: Gerling & Associates)

Satellite

Between the high-gain dish on the top of the truck (just under 100,000 or 45- to 50dB gain) and the highly directional receive characteristics of the Ku satellite, Ku trucks require transmitters with only a few hundred watts of power. The Ku satellites have a directional receive sensitivity pattern known as a conus pattern, not to be confused with the Conus organization, which operates a number of Ku satellites that facilitate SNG operations.

Ku satellites also allow a transponder to be split up, with two or more different trucks using the same transponder at the same time. With analog transmission the maximum number of trucks that can use the same transponder is two but, with digital transmission and its accompanying compression and modulation techniques, multiple transmissions can pass through the transponder simultaneously. With analog the split transponder is known as half-transponder use. Half-transponder use results in slightly noisier signals, but that is usually deemed OK for news applications, as the cost for transponder time is correspondingly less. Often on large stories where a news site has turned into a Ku truck convention, half-transponder use is all that is available due to the demand, especially during the news blocks of 4

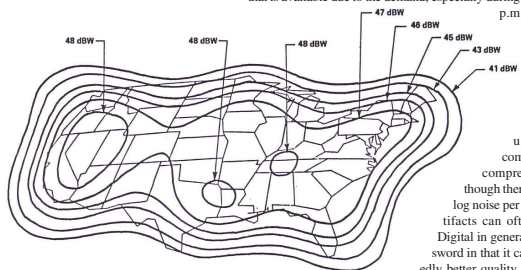


Figure 2.35 Example conus pattern. Ku uplinks from the center of the continental United States require less power than from the tip of Maine or Florida because of the satellite's receive sensitivity pattern. The values are the satellite's receive antenna gain for that part of the country. On a clear day, less than 100W out of the truck's transmitter is all that is usually required to saturate a Ku transponder. But a truck under the same conditions in Corpus Christie or at Key West could require four times that power. (Source: Conus Communications)

p.m. to 7 p.m. in each time zone. Digital signals suffer in split transponder use in the sense that the smaller slice of the transponder bandwidth used means higher compression, with more compression artifacts. Although there isn't the usual analog noise per say, compression artifacts can often resemble noise. Digital in general is a double edged sword in that it can provide for markedly better quality, but eats up tremendously more bandwidth. To minimize the needed bandwidth, lossy compression (which throws away parts of the picture that you hopefully won't miss) along with sophisticated modulation techniques of the digital data onto the RF carrier, gets the bandwidth back to the required amount. Digital transmission is a trade-off. It allows you to use less bandwidth, and in the end you pay for the amount of bandwidth you use, but too little bandwidth and the correspondingly high compression can make that old analog signal look good. But compression and modulation techniques and methods continually improve, and what looked bad at one bandwidth a year ago might be acceptable this year.



Figure 2.36 Inside compartment of a Ku uplink truck. This particular truck can also act as a small production truck, as it has a small video switcher (right bottom of photo) and mixer. The right three racks are for baseband audio and video. Baseband means the audio and video that has not yet been modulated onto a RF carrier. The right two racks take the audio and video and communications from/to the truck and turn them into RF signals for transmission up to a Ku satellite. This truck is equipped for both analog and digital transmission.



Figure 2.37 C-Band uplink truck. To get the same transmit power as Ku, a C-band dish must be larger because C-band frequencies are much lower than Ku and thus don't focus as sharply. On the other side, being much lower in frequency than Ku, C penetrates through rain and cloud cover much better than Ku. But the C-band is also more susceptible to terrestrial interference. C-band satellites don't have the directional receive characteristics employed with Ku, so C-band transmitters with powers up to 5000W are often employed with Ku. In fact some C-band satellites have the opposite receive characteristics, that is try and found. To combat people that would double illuminate a transponder, that is try and interfere with another's transmission, some birds' transponders can drop attenuators into their receivers. In this way, a full-power uplink transmitter can increase its power to outdo the interloper's uplink, usually an amateur device.

Don't Do This at Home!

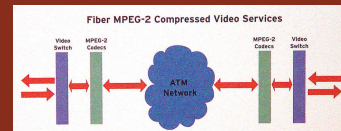
It should be stressed at this point that satellite uplinking is dangerous, and not something to be undertaken without proper training. First, many transmitters have lethally high voltages, and the current to cook as well as shock. But more dangerous, because it is easier to be in its way, is the RF power. Hundreds of watts of RF power can be coming out of a transmitter and channeled down a waveguide (plumbing for RF energy) only a centimeter or two wide. You wouldn't want to stare down that tube while it was in operation. Like plumbing used for water, waveguides can spring leaks. If the transmitter is on long enough, the leaks manifest themselves by heating up the area around the leak. Leaks are found by checking for hot spots only after the transmitter is turned off.

But if a waveguide is dangerous, so is what is reflected off the dish. A satellite dish takes the few hundred watts that the waveguide delivered and directs that energy in a single concentrated direction. This is referred to as the antenna's gain. A few hundred watts concentrated by a dish to produce a small aperture out toward the satellite can have the same RF intensity as a transmitter of many millions of watts. Standing directly in path of that much RF can kill. Satellite transmission levels are at least 50 and usually 100 times more powerful than any ENG microwave transmission. While microwave shots often intentionally bounce their signals, satellite uplink transmissions can never do that. A Ku dish can emit enough RF energy that it is unsafe for almost 200 meters out from the dish. Plus simply shooting through leaves can scatter RF energy so that instead of illuminating your intended satellite you now are hitting many. A Ku dish with no scattering has a beam width of hundreds of miles when it reaches the satellite. A two-degree spacing between many satellites means that in orbit they are only about 500 miles apart, which leaves little margin for error.

Landlines

ATM Video Transmission

Figure 2.38 Originally video and audio were converted to digital data for transport via Vyvx proprietary methods. Today, reflecting William's telephony roots, video and audio ride over an ATM network, after first undergoing MPEG compression. MPEG compression, which is a form of lossy compression, is necessary due to the high bandwidth required by the high bit rate of today's digital videos. MPEG reduces the bit rate by a factor of six for standard-definition video over Williams' network. The MPEG data stream is broken up and inserted into ATM cells for routing through the network. (Source: Williams Communications/Vyvx)



So at this point in our planning we've got a show to produce and a core production team to bring the project to air. We've surveyed the site and have determined space and power needs, as well as how we are going to get the signal from the venue to the television station or network. But there are still logistical issues to be addressed, which we will do in the next section. ■



Figure 2.40 Many paths back to the station or network today are over fiber optic cable. The leading provider of fiber paths for television is Vyvx, which is part of Williams Communications. Many venues and television facilities have Vyvx terminal gear. The video and audio signals are converted to digital data for travel over the network. (Source: Williams Communications/Vyvx)

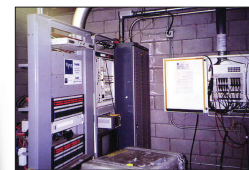


Figure 2.39 Vyvx/Williams terminal gear at a venue. If the video and audio are not already digital signals, the equipment in these racks converts them to digital, performs MPEG compression and wraps the MPEG data stream in ATM cells for routing through the network. (Source: Williams Communications/Vyvx)



Figure 2.41 Often, additional space must be obtained in the venue's press box for additional assistant producers and directors.



Figure 2.42 Often special equipment or appurtenance must be mounted on cameras such as this prompter system. Yes, some of the light from the prompter monitor does reflect into the camera lenses. So adjustments to the camera usually have to be made.

Logistics

Firming up the Plan

Earlier we discussed the development of a preliminary budget based upon potential ad sales and other factors. Now that the preliminary survey has been done, a review of potential expenses will take place. Usually prior to the initial survey, production has a general idea of the required equipment and staff. The survey should have refined those assumptions; for instance, maybe an extra camera is needed for that special shot. Perhaps there are special labor requirements with the venue's electricians or stage crew. Will additional lighting be required? These factors will all be included in a budget based upon that initial survey.

One of the biggest costs, next to labor and associated travel expenses, will be the charges for the mobile unit itself. In the United States, with the exception of Turner, the major broadcast and cable networks no longer own their own mobile units, but contract with vendors instead. Many networks have semi-exclusive relationships with these vendors. After the survey, the broadcaster will contact the vendor to discuss obtaining a unit for the project that can supply the required equipment and the costs for unit. Currently, mobile units operate in one of three formats: analog, digital standard definition and digital high definition. During the initial planning and survey the determination of which format to use will have been made. Analog trucks are still found at many remotes. Analog technology has advanced to a point where an analog truck in good repair will provide very good video and audio, especially for live events. The problem with analog vs. digital is that every step along the path from the camera, through the truck and all the way to your home, the video and audio are ever so slightly changed. The longer the analog path, the more the signal is impacted. With digital signals — except for equipment that is modifying the signal, such as video effects devices or an audio mixer — the signal is never changed, unless something is broken or wrong. It should be pointed out that in nearly all cases the signals from the venue to your home will be analog at some point. Even if you view the production on a DTV set, there is still a chance that the signal will be converted to analog for some of its journey.

High-end analog trucks are almost never built today, as the equipment that makes up the video infrastructure in a truck is often offered only in digital format. Audio is a different story. Some trucks are still built with analog audio, as the difference in “bang for the buck” with digital vs. analog has not been as pronounced with audio as with video. That is



Figure 2.43 Often a trailer full of lighting gear and associated power cable must be loaded in and suspended in a venue, as is often the case for an entertainment, or in this instance, an awards show.



Figure 2.44 The PM must arrange for most of the pieces that make up the television compound, such as the catering tent used for coverage of New York City's bicentennial celebration. (Source: NEP)

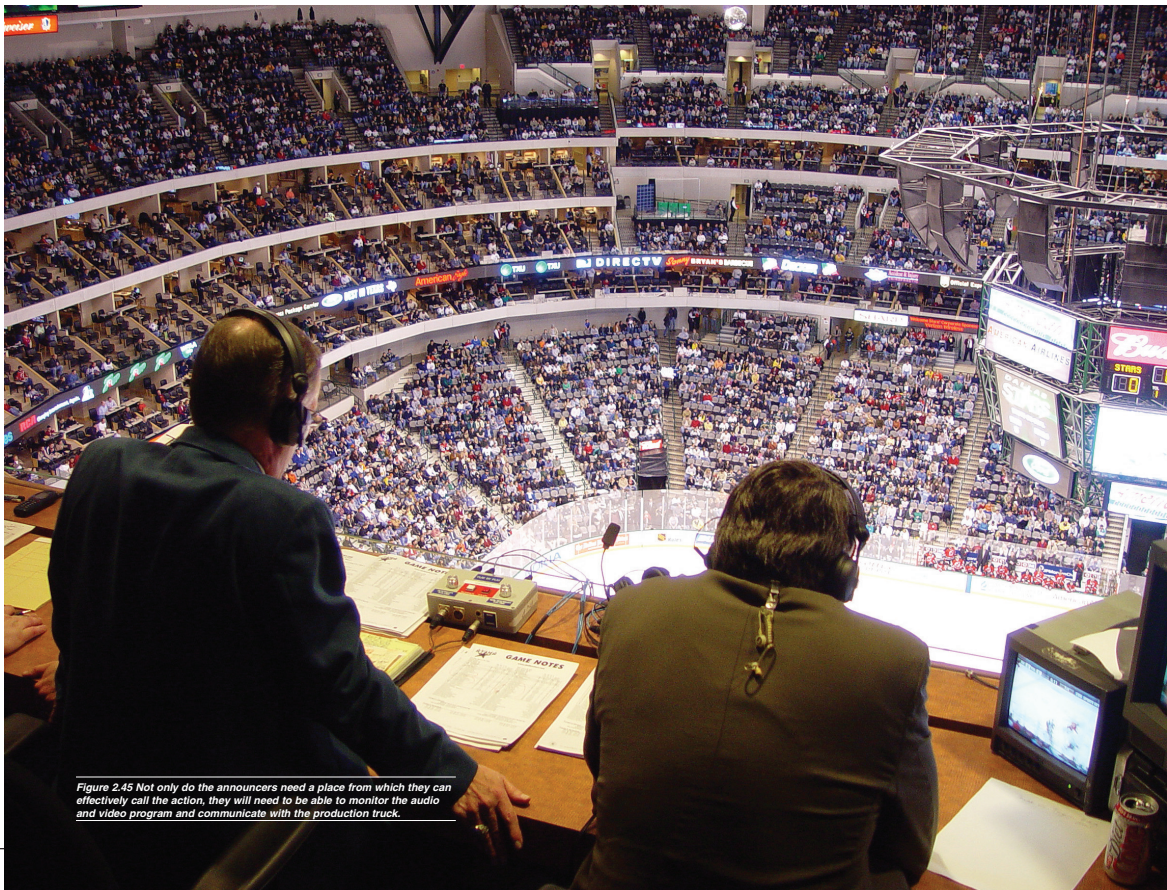


Figure 2.48 Not only do the announcers need a place from which they can effectively call the action, they will need to be able to monitor the audio and video program and communicate with the production truck.



Figure 2.46 Camera mounted on a jib arm. The camera at the end of the boom is controlled (pan and tilt) via cables, which are controlled by electric motors run by the jib operator. Besides allowing the camera to get where a mortal alone couldn't, the jib arm also allows for sweeping camera moves in which the camera appears to fly over crowds and action.

rapidly changing, but an analog truck can still do just about everything a digital truck can do.

Actually, there hasn't been a purely analog truck in about 20 years, as more and more equipment over the years has internally processed video as digital signals. These pieces of equipment are referred to as "digital islands." They take analog signals in, convert them to digital, do whatever processing they do using digital signal processing (DSP) concepts, convert the digital result back to analog, and feed the processed signal out. VTRs' time base correctors (TBCs) and video digital effects were early digital islands. Now digital equipment dominates trucks, and the islands are analog. For instance, many monitors in a digital truck are analog and digital signals fed to them must be converted to analog first.



Figure 2.47 Various cable runs, mostly originating from the truck, must have lengths and amounts determined. If the truck being used doesn't have the necessary lengths, additional cable must be shipped to the site. Most large production trucks carry well over 100,000 feet of cable.



Figure 2.48 Radio communication is often critical when setting up remotes. Often, due to frequency coordination issues, the necessary radios will be rented in the city where the remote will take place.



Figure 2.49 The types of cameras needed, either studio type (in foreground), which are also known as “hard” cameras, or handheld cameras (at rear and right of photo) must be determined. Also important is the lens that each camera will have. These studio cameras have 67:1 zoom lenses mounted. Most large



Figure 2.50 Whiteboard that keeps everyone informed of each truck's status and location. A truck vendor with many trucks may need to reconfigure a truck to meet the client's production needs.

The Crew

The television remote crew is made up of a mix of creative and technical staff members. We've discussed the producer, director and tech manager previously. In addition, there will be a technical director, cameramen, audio mixers, video operators, tape operators and graphics operators. Of course, there will probably be several cameramen, and there may also be several of each of the other key positions, as well as assistants for the producer, director and audio. Then there is a whole cadre of production support that may include writers, researchers, editors and statisticians. The mobile unit vendor will supply an engineer-in-charge, engineering maintenance and a driver. Utilities and runners round out the crew – but don't forget the announcers, caterers, generator operators and security.

A production manager (PM) serves as the logistics coordinator for our traveling circus. Our crew may be all locals, living in the area, or may be flown in for the production. Usually it's a mix of the two, and the PM coordinates travel arrangements. If some of the crew are out-of-town, hotels and rental cars are added to the mix.

Our survey will have indicated any specialized equipment necessary, such as jib arms. Typically the PM will make arrangements for any extra gear not supplied by the mobile unit. The PM also arranges for office trailers, catering, telephones, copiers and just about everything else. Really big shows will have multiple TMs and PMs concentrating on specific areas.

The Budget

When it's all said and done, the PM hits the total key for the anticipated project cost. If it's your typical production, cuts are made to bring the project into line budgetwise. The total number of cameras is a natural target for cuts. Thirty years ago, six cameras on a shoot was considered a large number; twenty years ago it was over 10. Now it takes 20 cameras to impress most in the business as a large remote. Large numbers of sources — be it cameras, VTRs (or video servers), and graphics devices — mean more trucks, more support pieces, more space and more time for setup. All of this equates to more money. The PMs and TMs earn their salary by providing the required production tools in the most economical way. But as is often the case, they must balance this against the expectations of the production staff and client.

In this section we've identified the additional crew and any additional or special equipment needed. We've made sure that our announcers, other talent and crew have the required working space, and that the production costs of the show are within our budget. Once everyone agrees on all these issues, it's time for the production book. ■

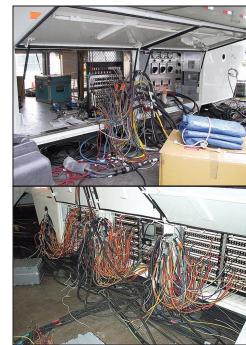


Figure 2.51 Running 20 to 30 miles of cable for a remote is no longer uncommon. The large cables that look like garden hoses are mults, multiple smaller cables bundled into a larger cable jacket.



Figure 2.52 Many venues, unlike this one, don't have provisions for cameras, cables or trucks.



Figure 2.53 Hard camera rig outside combination production/ku uplink truck. This situation greatly simplifies planning and setup.

The Production Book

Finalizing Plans

The tech manager and production manager will pull together all the technical and logistical details of the event into a production book. A good book serves as the show's bible, indicating all the camera locations, lenses, mounts, cable runs, microphones, intercom drops, monitors, video recorders and graphics devices. Also included will be an overall schedule; travel/work schedules for the crew; and airline, hotel and rental car information. Drawings of the venue showing camera locations are usually included along with a drawing of the TV compound area in which the crew builds the various elements of the remote, typically referred to as equipment setup (ESU).

Often the core of the book takes the form of a multiple-sheet spreadsheet, with each sheet handling various aspects of the production plan. Let's look at what should be in the book.

nep Camera Master

1000 1000



Figure 2.57 Often specialized pre-production editing trucks must be used, as depicted by the left photo. In addition, cameras are often in temporary venues and amid large crowds.



Figure 2.58 Map of the golf course showing camera placement. Also a list of scaffolding and other platforms should be listed. Height, length and width are noted. (Source: NEP)

Telephones will need to be ordered. Today that could include DSL and T1 lines. The initial survey would have included a check of what was available, as well as the name of the local phone company.

A list of all sources, both video and audio, is compiled, and initial assignments are made to monitors in the monitor wall and into the router and video switchers. Other entities may require signals from the mobile unit to feed large video screens and monitors in the venue. The venue may be able to provide data feeds from scoreboards and clocks that will need to be fed to graphics. A feed from the public address system for audio, and maybe even a camera or two, may also be used as sources.

Finally, a crew list will need to be compiled, making sure that all necessary operating positions are filled. Crew call times and other scheduling is usually added to the book as well.

In this section we've taken the raw information we've collected for our production and assembled it into a production book. Today, these books usually have a multipage spreadsheet at their core. The production book is the

bible for our show, and allows everyone involved to work from the same page, literally. Although no amount of pre-production planning can account for all contingencies, our production book should have most of the bases covered and obstacles solved. Once the planning is done, we should be ready for the next section, in which the truck(s) show up at the site. ■



Figure 2.59 R/C crane for mounting receive antennas for wireless mics and cameras. Compound is below behind the trees.

Figure 2.61 Cable runs are mapped out so that run lengths can be computed. The truck vendor and especially the truck crew should know what lengths of various types of cable are normally stocked on each truck. The normal truck stock for each type of cable is subtracted from the total needed for the shoot to find the supplemental cable load that needs to be sent separately to the venue. This information should be part of a load list that includes all the supplemental equipment that must be put on the truck, and where that equipment is coming from. (Source: NEP)

LOCATION	PLATFORM	DIMENSIONS	NOTES
FAIRWAY	3 SECTION SCAFFOLD	10 X 7 X 30	NOT to be used in 2003
TEE	2 SECTION SCAFFOLD	10 X 7 X 13	Behind 8 Tee Box
GREEN	1 SECTION STEP UP	5 X 7 X 8	Behind Green looking down Fairway
FAIRWAY	3 SECTION STEP UP	5 X 7 X 8	Golfers left at end of pines grass, 5 paces from 260 yard marker head towards fairway. Scan 1 grass as well.
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	Behind Green looking down Fairway
FLANK	1 SECTION STEP UP	5 X 7 X 8	Golfers Left of Green by Mount
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	Golfers Right of Green by Mount
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	NO BARS NO NAILS SEE 121 Memo Pad used here
FAIRWAY	2 SECTION SCAFFOLD	10 X 7 X 13	Move to end of pines grass to view 120 with ocean in back. All pines in front
GREEN	1 SECTION SCAFFOLD	10 X 7 X 8	EVEN WITH BACK EDGE OF GREEN
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	8 paces back from bunker head and 2 paces left
FAIRWAY	1 SECTION STEP UP	5 X 7 X 8	10 paces grass above bunker next to green golfer left.
FAIRWAY	2 SECTION SCAFFOLD	10 X 7 X 13	Remove front left post & rail.
FAIRWAY	2 SECTION SCAFFOLD	10 X 7 X 13	On the green side of the left path.
FAIRWAY	3 SECTION SCAFFOLD	10 X 7 X 30	240 Yard Marker - Golfers Left
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	Directly behind the Green
GREEN	2 SECTION SCAFFOLD	10 X 7 X 30	Behind Green looking down Fairway
FAIRWAY	3 SECTION SCAFFOLD	10 X 7 X 30	Provide Bunker head left of green: 11 paces toward back of green then 10 paces golfer right
GREEN	2 SECTION SCAFFOLD	10 X 7 X 13	Head onto support for the wind
TEE	1 SECTION STEP UP	5 X 7 X 8	DIRECTLY BEHIND TEE BOX
FAIRWAY	3 SECTION SCAFFOLD	10 X 7 X 30	Behind sprinkles box. Some vegetation needs
GREEN	3 SECTION SCAFFOLD	10 X 7 X 30	Placed in-between Grandstands Behind Green
TEE	1 SECTION STEP UP	5 X 7 X 8	Build this last
COMPOUND	1 SECTION HIGH	24 X 24 X 8	80 Feet 4-0 arranged by client
AWN BOOTH	1 SECTION HIGH	24 X 24 X 8	24 FEET BY 24 FEET 1 SECTION HIGH
Line Sections	47		Changes for 2003 in Red

Figure 2.60 List of scaffold requirements (Source: NEP). Cameras usually stay in a single location or, in the case of handheld cameras, in a single area. But golf is a different story. Cameras often are moved from one hole to another as play progresses. The required moves are listed, along with new cable runs that will be used.

