Set Lighting Technician's Handbook

Film Lighting Equipment, Practice, and Electrical Distribution

Fifth Edition

Harry C. Box

A **Focal Press** Book

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Set Lighting Technician's Handbook

A friendly, hands-on training manual and reference for lighting technicians in motion picture and television production, this handbook is the most comprehensive guide to set lighting available. It provides a unique combination of practical detail with a big-picture understanding of lighting, technology, safety, and professionalism, essential to anyone doing motion picture lighting.

The fifth edition delves into every aspect of lighting and features vastly expanded sections on controlling LED lights, color science, lighting control systems, wireless systems, Ethernet-based control systems, battery power, and modern set protocol for productions small and large. With a generous number of original images, the book illustrates the use of soft light, the effect of lighting angles, and how the gaffer and DP build an effective lighting plan around the blocking of the actors. This encyclopedic volume of technical knowhow is tempered with years of practical experience and a much-needed sense of humor.

This is the ideal text for professional lighting technicians across film and television including lighting directors, gaffers, DOPs, and rigging crews, as well as film and television production students studying lighting, camera techniques, film production, and cinematography.

It includes a revamped companion website with supplementary resources, forms, checklists, and images.

Harry C. Box has worked in the motion picture and television industry since 1987 with significant experience as a lighting technician and gaffer and later as a camera operator. Harry also works for the industry trade association ESTA focusing on issues relevant to the motion picture/television market.

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Visit the companion website: www.routledge.com/cw/box

For my mother and father

Contents

Preface

Lighting practices for film and television production have undergone many transformations since the summer of 1991, when I first began making notes for what eventually became the first edition of this book. At that time, the conversion from vintage DC distribution equipment to AC was still taking place. Lots of different distribution systems had popped up; there was no dominant standard for connectors and junction boxes. SCR dimmers were suddenly becoming a big part of motion picture lighting for the first time, bringing with them the attendant issues of harmonic currents. Electronic HMI ballasts were new to our industry and were pretty shaky at first. It took a few years of burning out different parts of the ballast before manufacturers arrived at the bullet proof reliability we have come to expect today.

At that time there was little or no formal training for lighting technicians. Electricians learned from each other on the job. For many old-school electricians, three-phase AC systems, power factor, current harmonics, and even grounding, were new concepts. At that same time, a much larger percentage of production in Los Angeles was non-union. Necessity being the mother of invention, these thriftier productions spawned many innovative lighting techniques that have since become common practices, but they also often resorted to methods that were actually potentially hazardous. One way and another there was a great deal of confusion and misinformation being circulated. It was in this context that I first undertook writing a book for lighting technicians in the film and television industry, with the goal of thoroughly researching the many issues I was aware of, in order to offer lighting technicians an authoritative source of information and guidance.

This book has existed in a time frame spanning a massive shift toward greater awareness and education for lighting technicians. To some extent, it has been a part of that shift. The fourth edition of the book reflected the formalization of training and rethinking of safety that occurred since the early 90s. Risks that were once casually accepted were now addressed with better technology and work practices. Things like using flammable materials or non-UL-listed parts, use of electricity around water, proper grounding, these are just a few of the areas where safety was improved in our daily work.

Revising a book is a great way to take stock of the impacts of technological change. The industry has just completed two enormous leaps forward—first the painful transition from film to digital capture in the early 2000s, and second, the LED revolution in the 2010s. What topic in this book has *not* been touched by this technology? It has given us a nimbler way to color light, which forced more sophisticated control technology. It has spawned new data/power management solutions. It has vastly increased our use of small power, like batteries, small generators, and house power. It has made rigging smaller and lighter and the production footprint not quite as deep. LED technology has changed the crew roles. Juicers now need to be IT technicians and RF engineers. It brought us systems techs, fixtures techs, and elevated the lowly dimmer board operator to full wizard status as lighting console programmer.

It has changed the way lighting technicians and gaffers work on set. It has taken light that was once static and breathed life into it, enabling it to move, morph, sputter, and travel. Built-in lighting effects, creative use of pixel mapping, the ability to fade between colors and to change the look, time of day, and atmosphere within the duration of a shot, DPs are finding exciting ways to harness the technology as tools for visual storytelling. Never before has so much been so relatively easy to do. While in some ways the changes have made things easier and increased the efficiency of production, they have also raised the expectations placed on DPs and on their lighting crews. The changes have added substantially to the knowledge base that lighting technicians need to master. So, with all that going on, we are clearly due for a new edition.

Acknowledgments

While writing the fifth edition, I was very fortunate to have the support of many top professionals in production as well as experts in the manufacturing sector. Their generosity, insights, and perspective make this book possible.

I gratefully acknowledge the many manufacturers who provided technical information, photographs, and illustrations. The manufacturers are listed in Appendix F.

I am very grateful to Mike Bauman for his generous input and terrific photographs. The man is an amazing wealth of creative talent and knowhow. Thanks to my friend and colleague Mark Doering-Powell for his ongoing advice and terrific artwork and photographs that appear in the book. I truly appreciate the continual feedback of Ted Hayash, Mark Weingartner, and Mike Ambrose, who also contributed photos. Thanks to programmer Scott Barnes for his thoughtful input, as well as the hospitality of Jared Wellman, Jason Young, Mark Hartman, and Jay Yowler who had me over for a set visit and shared their experiences.

Max DeMayo took the photo for the cover of this book. Thanks also to Al DeMayo, John Clisham, Paul Royalty, and Sean Goossen at LiteGear for supporting the project. Thanks to John Cini and the good folks at High Output, Boston for their generous hospitality. The fifth edition benefited greatly from those who read and commented on certain sections of the manuscript: Craig Brink and Adam Knapp at RatPac, Mark Wofford and Gary Murck at PC&E, Atlanta, Zack Shannon at CORE SWX, and Brian Doran and Jane Rein at ARRI. Guy Holt contributed his photos and perspective from his ongoing research into power quality issues. Frieder Hochheim and his team at Kino Flo shared research on LED color science.

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A special note of thanks to the illustrators, Shawn Murphy and Lisa Cyr, who created the hand-drawn illustrations for the first edition and who may well have been inking drawings on their wedding night to make the publication deadline. Thanks also to John Huey, who created additional artwork for the second edition. For new illustrations in the third edition, I thank Dan Haberkorn. Thanks to Laura Mancini and Keith Morgan.

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I am thankful, once again, to Joan Box, my faithful and talented (unofficial) copyeditor who has taken an interest in my writing since I was first able to form letters. It is a true testament to a mother's love that she endures all this techno mumbo-jumbo, but it is always a joy to work together on it.

Finally, my love, thanks, and appreciation go to my loving wife, Stacey, and to my family, who are officially completely sick of this book at this point, and with good reason. Thank you for your patience and support.

CHAPTER

Set basics: Your first barbecue

1

All the technical aspects of filmmaking—cameras, lighting, sound, visual effects—involve a myriad of small details that, taken as a whole, seem impossibly complex. As with any craft, to become a master requires years of experience and exposure to many different situations. It has been my experience, however, that no single piece of equipment, procedure, or technique is really complicated; there is no one thing that cannot be explained and understood in less than 10 minutes. Making movies is the artful application of millions of relatively simple details. This book helps with some of those details, describing procedures that save time and promote safety, clarifying aspects of the craft that are confusing and often misunderstood, and supplying a wealth of information about the hundreds of gadgets of which lighting technicians are so fond.

Starting with the basics, we begin with a summary of the role of the lighting crew on a film set.

JOB DESCRIPTIONS OF THE LIGHTING CREW

The electric, grip, and camera departments fall under the supervision of the *director of photography* (DP). The *gaffer* and *key grip* are the DP's lieutenants. The gaffer is the head of the electric department, in charge of the lighting crew. The gaffer's crew consists of a *best boy electric*, *lighting technicians*, and often a *lighting control programmer* or *dimmer board operator* and a rigging crew.

Director of photography

Q: How many directors does it take to screw in a lightbulb?
A: One; no, two . . . no, no one.

The DP is the director's right hand. It is the DP's responsibility to create in images what the director has envisioned for each scene; to evoke the proper time, place, and atmosphere by means of lighting; and to help choose camera angles and camera movement that will be most effective in telling the story and covering the scene. He or she designs the lighting, balancing realism against the dramatic potential of more stylized effects, as called for by the script and the director. The DP's responsibility for lighting and photographing the actors requires careful attention to how their face takes light. The DP must maintain proper screen direction (a responsibility shared with the script supervisor) and lighting continuity between setups so the film can be edited seamlessly. The DP has a say in the design and color of the sets and the wardrobe and in the selection of locations. The DP works closely with the *assistant director* (AD) to schedule scenes at the right time of day for the best light.

The DP usually shoots tests prior to the beginning of photography. He or she may experiment with lighting effects, with different color casts, levels of contrast and saturation, filters, and lenses that combine to create specific looks, which answer the special requirements of the script. The DP may also conduct his or her own research prior to production to ensure the authenticity of a period look and to inspire ideas for the cinematography.

The DP holds a position of immense responsibility, creatively and financially. The producer and director both depend on the DP to achieve photographic excellence within the constraints of the production's budget and schedule. The DP always faces conflicts in fulfilling the needs of the script, director, schedule, and budget and meeting his or her own aspirations for the photography. The lighting crew fights the DP's battles on the front lines. Their ability to light the set in a time-efficient manner directly affects the DP's ability to produce great work.

Gaffer

Q: How many gaffers does it take to screw in a lightbulb?
A: How many do we have on the truck?

The gaffer is the chief lighting technician (CLT), the head of the lighting department. He or she works directly with the DP to implement the lighting plan and help achieve the photographic look of the film. The DP, the gaffer, and the key grip attend preproduction meetings together and scout the locations where filming is to take place. They discuss the DP's approach to each scene and determine what lighting preparations and equipment are required. Gaffers are problem solvers. They often have to design a special rig, fabricate a gadget, or implement technology in some idiosyncratic way to give the DP something he or she is looking for, or to provide time efficiency during production. It falls to the gaffer and key grip to research possible solutions, source the materials, design all the specifics, and if necessary, present the plan to the DP and to the production manager for approval, and then see the plan to fruition.

On the set, the gaffer is responsible for the execution of the lighting scheme and the organization and operation of the lighting crew. The DP and the gaffer discuss the lighting. Typically, when talking about the actor's lighting, the DP may specify the placement of each fixture to accomplish a particular effect. Sometimes the DP may leave it to the gaffer to translate general ideas into specifics. The DP may express the goals in terms of the motivating sources of light for the scene, the mood, and the f-stop at which to shoot. The gaffer then instructs the crew and sees to the exact placement and focus of each light to accomplish the DP's instructions. Once the gaffer has executed the lighting, the DP may "sweeten" it to taste, with a few adjustments.

The gaffer must have a very strong eye for lighting and a solid knowledge of which lights to use to create any desired effect. As the lighting starts to come together, the gaffer functions as a second pair of eyes for the DP, always on the lookout for problems—inadequate light, overexposure, hot spots, ugly shadows, and so on. Together, the DP and gaffer look for opportunities to make the scene look more interesting. The gaffer has a critical eye for the balance of light and shade, the modeling of facial features, and the separation of foreground from middle ground and background. He or she may carry a light meter on their belt for measuring light levels. The gaffer is often next to the DP, viewing the monitors, watching for lighting issues and calling for adjustments over the walkie-talkie.

A very important part of the gaffer's job is organizing and running the lighting operations. He or she must constantly be cycling through the many tasks at hand, pushing forward the progress of each project, keeping an eye on the performance of the lighting crew, thinking ahead so that the lighting technicians will have power and lights readily at hand for subsequent shots, and forestalling delay.

The gaffer should never have to leave the immediate area in which the action is being filmed. He or she must rely on the crew to be close at hand to make lighting adjustments and fetch equipment when it is needed. Once the lighting is complete, the grips and electricians clear the set, but remain nearby, in case a tweak is called for between takes. The lighting crew is always under time pressure. A technician who stays near the action, listens, and thinks ahead can do a lot to help the gaffer and DP win their daily battle against time.

Best boy electric

The best boy electric is the assistant chief lighting technician. He or she is in charge of personnel and equipment for the electrical department—a vital role in the smooth running of the lighting crew. One of the best boy's duties is scouting locations with the gaffer, making scouting notes to help the gaffer compile the list of equipment needed. The best boy supervises the equipment inventory from the load-in at the beginning of the show, through each day of the shoot, and through the wrap and return. The best boy orders expendable supplies. He or she coordinates equipment orders, returns, subrentals, and special orders with the production department and transportation departments as necessary. The best boy supervises the loading of the truck at the rental house before the first day of production, organizes the equipment and supplies in the truck for easy access, makes sure that no equipment gets lost at each location, and keeps track of damage. The best boy supervises maintenance and repairs when possible. The best boy is in charge of hiring and laying off additional lighting technicians when needed. The best boy supervises the electrical crew's startup paperwork and time cards. When there is no rigging gaffer hired, the best boy may also plan the routing of the feeder cable and supervise the distribution of electrical power to the lights.

Most important, the best boy is the emissary of the electrical department, communicating and coordinating with other departments, with the fire marshal, and with rental houses, and other equipment suppliers. A best boy who maintains good relations with each department can get cooperation when it is needed. For example, when the best boy needs to put a light on the roof of a building, the locations team must make the necessary contacts to secure that spot. When the best boy needs some extra equipment delivered quickly, his or her relationships with the transportation department and the contact at the rental house come into play. The best boy's diplomacy is key.

Lighting technicians

Q: How many electricians does it take to screw in a lightbulb?
A: It's not a bulb, it's a globe.

Affectionately known as *juicers* or *sparks*, electricians are officially titled *set lighting technicians* or *lamp operators*. The electrician's primary responsibility is placing and focusing lights according to the wishes of the gaffer. At each location, the electricians unload and reload the lighting equipment from the trucks, run cabling, and run the distribution of electrical power for the lights. On the set, electricians are responsible for placing and focusing (aiming) the lights; manipulating the intensity, direction, color, and quality of light; wiring practical lamps (such as table lamps and wall sconces), switches, and wall outlets on constructed sets; and anticipating the needs of the gaffer so that equipment is at hand when needed. Lighting technicians secure lights and stands; however, the grip department also plays a role, such as hanging pipe or truss for the lights, securing a stand with straps, or screwing it down with grip-chain.

There is a Zen to the job of the lamp operator. An experienced lamp operator handles the equipment with deft speed and economy of movement that comes with familiarity. Through the exchange of a few words or hand signals, or by clairvoyance, the electrician grasps the gaffer's intention and manipulates the lamp to create the desired effect. His or her focused concentration is on two things: the activities of the lighting crew and the behavior of the light. The lamp operator is constantly attentive to the DP and gaffer and to fellow electricians who might need a hand. Simultaneously, the electrician is aware of the light falling, blasting, leaking, and spilling onto the faces and the surfaces around the set.

The set lighting crew may be asked also to provide power for fellow crew: camera, sound, dolly, and video village. Lighting technicians typically relinquish responsibility for powering vehicles at the base camp to the transportation department. Although powering the base camp is technically within the union jurisdiction of lighting technicians, being trained to handle electrical distribution equipment, most of the time the gaffer simply does not have the personnel to spare for anything extraneous to the set. Despite the nickname, movie electricians are very rarely licensed journeymen or master electricians. They are not qualified to wire buildings or work inside electrical panels. Their job is lighting movies.

Lighting control personnel

Lighting control refers to controlling lighting remotely via a control console, dimmer board, laptop, tablet or other device. A person who operates a computerized control console is called a *lighting control programmer*. A person who operates a dimmer board is called a *dimmer board operator*, or *board op*.

The importance and sophistication of this position on the crew has evolved drastically as lighting devices have gone from having one controllable parameter, via dimming, to having many parameters of control including color temperature, hue, saturation, and special effects. On a good-sized set, it is common for the programmer to have several thousand control channels under their command. The programmer is responsible for organizing the system including supervising assignment of DMX channels to lighting devices, selecting control modes and other device settings, running data lines, setting up wireless networks, and protecting these systems from failure and interference.

The programmer is responsible for grouping and organizing the devices on the control console so that even a large number of lights can be controlled in an intuitive and functional manner. The programmer must be able to respond quickly to instructions from the gaffer or DP to set levels and colors, write lighting cues, and execute the cues during the take. The programmer typically saves important lighting setups as cues so the levels can be recalled for future setups, so the task of organizing and archiving the data is also part of the job.

On a big production, responsibilities are delegated to one or more *systems techs* (also called *DMX techs* or *control techs*). There may be any number of people organizing and addressing DMX512 devices or assisting in other aspects of setting up and maintaining communication networks and control systems. When a lot of moving lights are used, the production may also have one or more *moving light techs*.

Rigging crew

A rigging crew is an important part of almost any project, be it a feature, episodic TV series, or even a television commercial. The rigging crew works ahead of the main unit, installing cable and distribution boxes, hanging lights, and taking care of any work that will be time-consuming for the main unit

to accomplish on the day of filming. The electric rigging crew works in tandem with the grip rigging crew. This may involve weeks of work to rig a major set or half a day laying in some cable on location.

A rigging crew consists of a rigging gaffer, rigging best boy, and rigging electricians. A rigging crew is invaluable to a production, especially to the DP and gaffer. The thought, planning, and careful, unrushed work, testing, and troubleshooting put in ahead of time translates into smooth sailing for the shooting crew. A properly rigged set means that the lighting will look better and the unit lighting technicians can work with greater efficiency. *Unit* lighting technicians are the *on-production* team, as opposed to the rigging crew who are *off-production*. *First unit* and *second unit* refer to separate film crews working on the same production. First unit typically works with the principal actors, while a second unit typically works on setups that would be too time consuming for the first unit, such as visual effects, miniatures, animals, establishing shots, beauty shots, but sometimes actual scenes with actors as well. The rigging crew usually also wraps out the set after the unit crew has finished with it.

The fixtures person (or department)

More and more, sets that require a futuristic or otherworldly high-tech look or a whole lot of razzle-dazzle are lit mostly by LED light engines that are built into the set. The set essentially lights itself. Often built-in lighting is selected to create a wide variety of colors and looks, so the look can change radically and be adaptive to whatever dramatic action is taking place.

On tentpole movies, the fixtures department can be bigger than the rigging crew, filling dozens of universes of DMX with lights throughout the set. The fixtures department is responsible for all the on-camera lighting. To avoid problems like flicker and color temperature issues, and because it needs to be controlled with the rest of the lighting, on-camera light sources need to be selected and supervised by a lighting technician who is a specialist in fixtures. Just like the first unit gaffer, the fixtures supervisor has to work closely with many other departments. For built-in lights they work with set design and construction. For *practical lights*, such as a sconce or table lamp, they work with the set decorator. Sometimes wardrobe has lighting in it like space helmets or underwater helmets, which involves issues of safety, practicality, and comfort for the actor. Like the gaffer, the fixtures person has to be smart, respectful, and collaborative in their conversations. Maintaining good relationships with the producer's team and other departments is essential to keeping things moving smoothly. The right personality is quite critical.

The skillset of top fixtures people has to be pretty diverse. They have to be familiar with fabrication techniques in a variety of materials—metals, fiberglass, plastics. They have to be comfortable specking-out and replacing electronics for practical lights when off-the-shelf electronics are unsuitable. They could be called upon to control any kind of light, which can include challenges like controlling the headlights of a moving vehicle, for example. They have to organize large data networks and work with a variety of control protocols including pixel mapping protocols in addition to standard Ethernet and DMX. Since the lights are to be photographed, there's also aesthetic and design decisions and careful craftsmanship involved.

Generator operator

The generator operator is in charge of the full-time operation and maintenance of the generator. A knowledgeable, experienced generator operator is an extremely valuable person to the set lighting department. Most genny operators today are teamsters. The production van driver typically operates the generators on the tractor. There is no special training, test, or apprenticeship program to be a

generator operator. People who lack the proper experience are of absolutely no use to you when a generator starts to hiccup. Especially when you are on a remote location where a generator cannot be quickly replaced and you encounter issues with climate, fuel, and other conditions that affect the generators, it is especially worthwhile for the gaffer and DP to insist on using a qualified generator operator.

Grip department

Q: How many grips does it take to screw in a lightbulb?
A: Grips don't change lightbulbs. That's electric.

Nonelectrical lighting equipment is handled by our brothers and sisters in the grip department. A grip is affectionately called a *hammer*. Silks, diffusion frames, flags, reflector boards, rigging, dollies and dolly track, cranes, jib arms are all in the domain of gripology. You could say that the lighting technicians do the lighting and the grips do the shading. Each time an electrician sets up a light, a grip is right next to him or her with a *grip package*, which includes a C-stand and whatever flags, nets, or diffusion frames may be needed in front of the light. Lighting technicians graduating from the nonunion world may be used to grips taking charge of placing sandbags on the light stands, providing ladders, and leveling large stands when they are placed on uneven ground. On union jobs in Los Angeles, the electricians generally handle their own ladders, sandbags, and rigging hardware, such as pipe clamps. Grips handle gel and diffusion when used on a frame or applied to windows. An electrician applies the gel and diffusion when it goes directly on a light.

Grips are responsible for the safety of the rigging, and they are often called on to rig support for lighting equipment and backdrops. Truss, I-beam rails, chain motors, speed-rail grids, wall spreaders, and similar rigs are built by the grips. When lights are to be hung from an overhead grid or rigged to the wall of the set, the grips generally rig the support. An electrician then clamps on the light, plugs it in, and focuses it. When lights are mounted on a high platform, on top of parallels, in the basket of an aerial lift, or on an elevated platform, the grips rig and secure the light and light stand. When an interior night scene needs to be shot during daylight hours at a practical location, the grips build big black tents around the windows to create darkness outside, while providing space for lights outside the building. During production the grips are in charge of removing, and reinstalling set walls as needed during filming.

The head of the grip department is the *key grip*. The key grip supervises the grips in the same way that the gaffer supervises the lighting technicians. He or she works for the DP in tandem with the gaffer, supervising the grips in the placement of grip gear in front of each light.

The key grip's chief assistant is the *best boy grip*. The best boy grip coordinates the grip crew in the same way that the best boy electric does the electric crew.

The *dolly grip* is in charge of operating moving-camera platforms, such as dollies and cranes: laying and leveling the dolly track, moving the camera smoothly up and down and to and from exact marks with precise timing. Grips also rig support for the camera when it is placed in unusual places, such as on top of a ladder or on the hood of a car.

THE COMPANY

A film crew is composed of freelance artists, technicians, and actors who are brought together by the production company when the production is ready to be mounted. The producer and director select the department heads: the DP, production designer, sound mixer, editor, and so on. Each department head usually brings his or her own staff to the production. Usually the DP recommends a gaffer, key

grip, camera operator, and camera assistants with whom he or she prefers to work. The gaffer, in turn, recommends lighting technicians he or she knows and trusts.

Each production brings new faces, new locations, and new circumstances, yet you can count on certain constants in relationships between electricians and the other departments.

Production staff

Q: How many production managers does it take to change a lightbulb?
A: None! If you'd just make it a day exterior we wouldn't have to keep screwing around with all these lightbulbs!

Officially, the crew is hired by the producer. Although the gaffer usually selects electricians for the crew, once an electrician is offered a job, it is the *unit production manager* (UPM) with whom he signs the crew deal memo. The UPM authorizes paychecks that are handled by the accounting department and issued through a payroll company.

The duties of the UPM include establishing and controlling the budget, making deals for locations and services, booking the crew, overseeing daily production decisions such as authorizing overtime and making schedule changes due to weather, and managing all the off-set logistics, including housing, meals, transportation, permits, security, and insurance. Because the UPM is responsible for executing the budget, he or she must approve all equipment orders and personnel requests.

Some productions have a *production supervisor* as well as (or in some cases instead of) a production manager. This distinction between production manager and production supervisor is that a UPM has served many years as an AD and has joined the Directors Guild of America (DGA), whereas a production supervisor has not. Typically, a supervisor has previously worked as a production coordinator working in the production office, not on set.

The *production coordinator* assists the production manager. His or her duties include booking the crew, booking and returning equipment, ordering expendables and supplies, monitoring petty cash, distributing production information to the various departments, and coordinating and distributing the shooting schedule and script revisions. The production manager, the production coordinator, and their staff work out of the production office, along with the accounting department.

The director's team

The "director's team" consists of the ADs, the production assistants (PAs), and the script supervisor.

Assistant director

During preproduction, the first assistant director (1st AD) prepares the script breakdown and production schedule and coordinates the actions of every department and the cast. He or she plans each day's schedule and gives final approval to each day's call sheet, which is usually prepared by a second AD. During production, the 1st AD runs the set. He or she is responsible for keeping the production moving and on schedule on an hour-to-hour basis. The 1st AD keeps everyone informed about the shots, constantly plans ahead and facilitates, coordinates, and motivates the actions of the crew in order to solve problems before they occur. The 1st AD must stay informed of any potential delays or problems. Every production company is required to have an appointed safety officer. On a studio lot, the safety officer is provided by the studio; for independent shows, the 1st AD is the default safety officer. Part of the 1st AD's job is calling and running safety meetings. An onset safety briefing, for which all the relevant

crew are assembled, is given to alert the crew to the specific safety issues of the shot, the location, or the day in general.

The 1st AD is backed up by a 2nd AD, who in turn are helped by 2nd 2nd ADs and a squad of PAs. The AD staff takes care of the actors: coordinating their schedules, and ushering them through makeup, hair, and wardrobe and to and from the set. The AD staff also directs the action of background artists (extras) and supervises crowd control.

ADs and PAs can be called upon to help coordinate between departments. For example, if a lighting technician needed some furniture moved to place a light and the onset dresser was nowhere in sight, the 1st AD would have him found in short order.

Prior to the first take, the AD calls "last looks," which alerts the makeup, hair, and wardrobe onset personnel to make final touches. The 1st AD initiates each take by calling "Picture is up," a warning to everyone to finish whatever they are doing and get ready for the take. This is followed by "Roll sound." These instructions are broadcast over the walkie-talkie to all the ADs and PAs, who echo "Rolling" throughout the set, so that everyone knows to settle in for the take and be quiet. Following the take, "Cut" is broadcast by the 1st AD, and again, the AD staff echo it for the crew.

Other announcements:

"We're in" or "We're back." Announced at the start of the day and after lunch respectively to call the company to work.
"Going again." A second take will be rolling immediately.
"Hold the roll." There has been a momentary delay. This cues the sound mixer to stop recording while the problem is fixed.
"MOS." Sound will not be recorded for the shot. The term comes from the early days of sound. It is an acronym for "minus optical stripe."
"Fire in the hole!" Announced before gunfire or explosions. Be prepared for a loud noise to follow.
"Check the gate." If the project is captured on film, after each shot has been successfully completed and the director is ready to move on, the camera gate must be inspected before the next shot is announced. If there is a "hair" in the gate, the shot may have to be retaken.
"Moving on" or **"New deal."** The director is ready to move to the next setup.
"Turning around." The next setup is the reverse coverage or sees the scene from the opposite direction.
"Company move." The next setup is at a new location.
"That's lunch, one half-hour." The company is at lunch. You can head to the catering truck, or do something else, just be back in 30 minutes.
"Abby Singer is up." The Abby Singer is the second to last shot of the day. It was named for (former) AD Abby Singer, who always had "just one more shot" after the last shot of the day.
"Martini is up." The martini is the last shot of the day. (Your next shot will be out of a glass.)
"That's a wrap." The last shot of the day has been successfully completed. If filming has been completed at this location, the lighting crew begins wrapping: taking down the lights, coiling the cable, and loading the truck.
"Make it safe," "Walk away." When filming will resume in the same place, and things can pretty much stay where they are, the ADs may say "make it safe."

Script supervisor

The *script supervisor* makes careful notes on the script and keeps a running log that shows scene and take numbers, lenses used, shot scale, movement, eyeline direction, good takes, flawed takes (and the reason why they were flawed), line changes including ad libs and flubs, and so forth. These notes are used to recall matters of continuity and to note for the editor what coverage was taken and which takes the director thought were the best. In a way, the script supervisor is the onset advocate for the editor, consulting with the director on questions of screen direction and coverage. Matters of continuity are often small details that have to be carefully noted—in which hand an actor holds his beer, at what point in the scene he puts out his cigarette, whether his shirt sleeves are rolled up . . . all the things that everyone sees but no one notices. For this reason, it is vital for her (or him) to be able to see the action on every take; if you stand in her way, you risk being jabbed by her sharp little pencil. The gaffer sometimes has the best boy take detailed notes on the placement of the lights, especially if the scene may be replicated at another time. The script supervisor can provide the best boy with the applicable scene numbers for these notes. The camera assistants and sound recordist also get this information from the script supervisor.

Camera department

Q: How many camera assistants does it take to screw in a lightbulb?
A: Five. One to screw it in and four to tell you how they did it on the last show.

The camera department is made up of the DP, camera operator, first camera assistant, second camera assistant, and, when shooting in a film format, a loader. When shooting in a digital format, the camera crew may include a *digital imaging technician* (DIT) and a camera/digital utility person and digital loader.

The *camera operator* sets the shot and operates the camera. The operator is charged with the responsibility of keeping the lights, grip equipment, and microphones out of the shot. If you are setting a light close to the frame line, the camera operator can tell you where it is safe. It is a very good idea that the camera operator set the shot before the lighting crew starts lighting it, as important details, such as the exact placement of the actors, and what background will be photographed, may change during this process. Although this may cause the lighting crew to hold off on the work inside the set for a couple of minutes, ultimately it saves having to set lights twice.

The *first camera assistant* (1st AC) is responsible for the camera, including building it, configuring it (physically and in terms of electronic settings) for each shot, making lens changes and performing regular maintenance as needed. During the take, the 1st AC keeps the camera in focus and may perform any of a multitude of other tasks—zooming, making an aperture change, or ramping the shutter speed or angle. The 1st AC never leaves the camera's side.

From time to time, the 1st AC calls on the lighting crew to help get rid of lens flare—light hitting the lens that may flare on the image. Usually the grips can set a flag or hang a "teaser" to keep the light off the lens.

The 2nd AC aids the 1st AC with lens changes and magazine changes, marks the actors' positions, slates each shot, and keeps the camera reports and film inventory. Almost all camera equipment runs on batteries, but a 2nd AC needs power to run a video monitor. When a director uses a video monitor, it quickly becomes habit to supply power to the monitor as soon as the camera is placed. Similarly, a hot extension cord should be supplied for the dolly at all times.

Sound department

The *sound mixer* oversees the recording of audio. The sound mixer is the one person on the set fortunate enough to perform his or her job from a sitting position. If you want to know the sports scores, he or she almost always has the newspaper at the sound cart.

The *boom operator* is the person who actually positions the microphone within range of the actors, by holding it on a pole over their heads, wiring them with radio mics, or planting hidden microphones on the set. When a power cable must cross the microphone cable, the electrician should run it under the microphone cable so that it doesn't restrict the boom's movement.

The boom operator has to contend with shadows cast onto the actors and walls by the microphone and the boom pole. Boom operators are very good at analyzing the lighting and use great ingenuity to avoid casting shadows. The lighting crew helps the boom operator by setting toppers on lights as needed to eliminate microphone shadows. Certain lighting directions are inherently problematic for the boom operator. For example, hard front light from the direction of the camera tends to throw mic shadows onto actors, set dressings, or walls that are right in line with the actor being filmed. Raising the light higher so that the light is angled downward and then topping the light can eliminate the problem. Steep, top-down lighting is another difficult angle for the boom mic, because it tends to throw microphone shadows across the actors' clothes or table surfaces. Sometimes, the lighting is such that a boom microphone simply cannot be used, and the sound department must accommodate by using other methods such as radio mics.

The sound department has a vested interest in proper placement of the generator. Even with baffles to deaden it, engine noise can be a nuisance. Ballasts and dimmers usually hum and can become a concern for sound. Place them as far from the microphones as possible—preferably in another room or outside. Obviously, cell phones must be *off* during rehearsals and filming.

Dimming, light cues, and lighting effects create electrical "noise" in the power supply. The sound cart should be powered via separate utility power. All crew members must check with an electrician before plugging in their own electrical equipment; mistakenly plugging an expensive monitor into a dimmer channel, for example, is an experiment you don't want to be a part of.

Locations

Q: How many fire safety officers does it take to screw in a lightbulb?
A: One, but it's an 8-hour minimum.

A script might call for a city street, department store, hospital, church, factory, private residence, prison, airport terminal, office building, hotel lobby, or postapocalyptic tundra. Many settings can be more easily (and cheaply) filmed at an existing real site than recreated on the studio stage or lot. Whatever the case, the locations department finds, secures, and coordinates the film's locations.

When on location, any questions or problems pertaining to the building or grounds (such as rigging lights to the structure or access to locked rooms or circuit breaker panels) are handled by the building rep or building engineer through the *location manager* or his or her assistants. The location manager must sometimes wrangle tough situations with members of the public or employees of the location. It is best to defer any questions from these people directly to the location manager or the ADs. The location manager obtains permission to place lights in unorthodox places. Any kind of rigging that might do harm to a location or otherwise alarm the owner must be preapproved through the location manager.

Care must be taken not to damage the location. The places that are most at risk of damage are floors, walls, doorway moldings, and garden plants. When a house has hardwood floors, for example, the

grips and lighting technicians can put rubber crutch tips on the legs of the stands and ask that layout board be put on the floor to protect it. Some locations impose restrictions on the use of their property. Working on a period movie, you may well find yourself shooting in a historical building with irreplaceable architectural detail. It is often the location manager's task to enforce whatever rules have been established at the location (and contractually agreed to by the producer), rules that may conflict with the needs of the lighting department. In these situations, keep in mind that it is the director's desire to film the location and it is your job to make it work. It will usually involve extra time and trouble, but it is more important to keep the location manager as an ally and to help preserve good relations with every location the company uses. In the greater scheme of things, it is better for our whole industry if the public views film production as a positive experience.

Transportation

Q: How many teamsters does it take to screw in a lightbulb?
A: Four. You got a problem with that?

The drivers are responsible for operating and maintaining all the production vehicles. In addition to the "production van" (usually a 40-foot truck that carries all the lighting equipment), transportation provides passenger vans to shuttle the cast and crew, stake beds trucks with hydraulic lift gates for delivering equipment, and any other vehicles that are needed. Stake beds are particularly useful on location when equipment needs to be shuttled to several sites in one day or must be dispersed over a large area. Drivers may also be dispatched to make runs to return or pick up equipment from suppliers. It is a good idea for the best boy to give the *transportation coordinator* as much advance warning as possible, as needs arise.

Art department

Q: How many art directors does it take to screw in a lightbulb?
A: Does it have to be a lightbulb? I've got a really nice candelabra we could use.

The construction crew builds the sets, the *set dressers* decorate the set with items not handled by an actor, and the *props department* is responsible for anything that is handled by an actor. Wall lamps, practicals, "oil" lanterns, and the like are provided and placed by the set decorators. Wiring them is taken care of by a lighting technician. During production, the *onset dresser* and his or her helpers are responsible for caring for the furniture and all elements of decoration. If a piece of furniture needs to be moved, or a picture frame removed from the wall, ask the onset dresser to do it. If you do it yourself, it will break; it's an immutable Law of Set Dressing.

Hair, makeup, wardrobe, stunts, special effects, first aid, craft service, and catering are the remaining departments on the set that electricians need to consult from time to time. They are all essential parts of the production and it pays to stay on good terms with every department.

THE GENERAL PUBLIC

One more group with whom you will come into contact, especially when working on location, is the general public. Everyone on a film crew knows how important it is to establish and maintain good relations with the

public. No one knows this more than the location manager. On location, more often than not, a film crew is a guest in someone else's house. We constantly hold up traffic and ask people to be quiet during takes. By our very presence, we often put someone out. Although typically the location is being paid well for the trouble, every flower that gets trampled in the garden, every unthinking curse word uttered within earshot of sensitive ears, and every piece of equipment left in someone's way makes the public less inclined to cooperate and to let us do our work. A disgruntled neighbor may confront the first person he or she sees, sometimes quite rudely. It is the job of the locations manager and production manager to deal with complaints. As lighting technicians, our role in all this is minimal but important. Treat any comment or question from the public with politeness and professionalism. Help the locations manager stop trouble before it starts by pointing any complaints or problems his or her way. Get approval before placing a light somewhere that it is going to annoy civilians; that way, the location manager has a fighting chance at preemptive diplomacy. When locations or production make specific rules or requests with regard to working in a location, know that they are doing so because the issue is *already* sensitive. If they tell you to wrap out quietly, they are doing so because there have *already* been complaints about the noise. Many communities have ordinances that require quiet after 10:00 p.m. and no trucks and work before 7:00 a.m. In cities like Los Angeles, New York, Toronto, and Vancouver, a large segment of the population has had a bad experience with film productions, which makes it very difficult for production to work on location. There are also those who have learned that they can extort money from a desperate production manager and make noise and get in the way until they are paid. As much as possible, these are behaviors we'd like to change.

Okay, let me just finish off the list:

Q: How many stunt men does it take to screw in a lightbulb?
A: Five. One to screw it in and four to tell him how bitchin' he looked doing it.

Q: How many studio execs does it take to screw in a lightbulb?
A: No one knows. Lightbulbs last much longer than studio execs.

Q: How many actors does it take to screw in a lightbulb?
A: 100. One to screw it in and 99 to say they could have done it better.

Q: How many screenwriters does it take to change a lightbulb?
A: The lightbulb is IN and it is staying IN!

Q: How many editors does it take to change a lightbulb?
A: If we change the lightbulb, we'll have to change everything.

Q: How many grips does it take to screw in a lightbulb?
A: Two. One to hold it and the other to hammer it in.

One final note about working with the crew. This entire book is about the nuts and bolts of being a lighting technician. That's the job. But this knowledge is only maybe 10 percent of what makes you a success. The rest is your personal relationships, your ability to listen and communicate, to get the job done smoothly and reliably without ruffling other people's feathers.

BLOCK, LIGHT, REHEARSE, TWEAK, SHOOT

Progress on the set is measured in *setups*. A feature film crew may shoot two or three pages of script a day. For a television single-camera show, the average is four to eight pages per day, typically 20–30

setups per day. The AD and DP work together to determine an efficient shooting order for the needed shots. Conventionally, wider master shots are photographed first, establishing the lighting for the scene. Closer coverage, which usually requires refinements to the master setup, follows.

Although it is convenient when the shooting order is efficient for lighting, the DP and gaffer respect the fact that sometimes the AD may have other priorities. Shot order may be arranged to give precedence, for example, to a particularly difficult performance or a stunt that destroys part of the set, or to finish the work of an underage actor who can work only limited hours by law. Removing and reassembling walls of the set is often necessary to accommodate camera movement and lighting. Because this takes some time and is labor intensive, "wall order" is the kind of thing that the DP and AD want to take into account when planning the shot order.

Ideally, each new scene follows these five steps in order:

1. Block
2. Light
3. Rehearse
4. Tweak
5. Shoot

First the director, the DP, and the actors block the entire scene (i.e., plan the staging). During blocking rehearsal, the set is usually cleared so that the actors and director can work without distraction. The director and principal actors are called the *first team*. Once the scene is ready to show, the AD calls a "marking rehearsal," and all key crew pile into the set and watch. The gaffer, key grip, and camera operators learn a great deal from the marking rehearsal, and they must pay close attention, as this is typically their only chance to observe exactly how the actors intend to play the scene before they have to start lining up shots and begin lighting. The 2nd AC marks the actors' positions with tape at their feet.

Once the scene has been blocked, the actors are sent to makeup and the DP begins setting the shots and then the lighting. Often, the lighting crew has already roughed in some of the lights during a prelight. Stand-ins, who act as models for the gaffer and DP while the lights are placed, replace the actors. The *stand-ins* are known as the *second team*. The camera crew sometimes rehearses complicated camera moves using the stand-ins to save the principal actors from technical rehearsals. When there are lighting cues during the shot, and the second team rehearsal is the lighting crew's best opportunity to rehearse them and make adjustments.

Once the lighting is in place, the AD calls the first team back to the set for final rehearsal. He or she calls, "Quiet please. Rehearsal's up." The actors run through the scene with the camera and sound crew to iron out any remaining problems. The AC gets final focus marks. After one or two rehearsals, the scene is ready to shoot.

A basic piece of set etiquette that every crew member knows: stay clear of the actors' eyelines during rehearsals and takes. Be mindful of the level of concentration that acting requires, and cause as little distraction as possible.

Block, light, rehearse, tweak, shoot is a paradigm that provides all the crew members the information they need to act independently to bring all the details of the shot together smoothly. Nonetheless, there are times when some directors and ADs would clearly prefer to bypass the first four steps. The truth is lighting without blocking first always causes delays when the actors arrive and do things differently. The crew needs to actually *see* a blocking rehearsal. This gives the crew almost all the answers they need to prepare the scene. Not doing so leads to a barrage of unanswerable questions from every

department. Trying to shoot without rehearsing and tweaking almost always results in delays while problems are addressed, followed by retakes. The DP needs an opportunity to tweak the lighting after the final rehearsal because inevitably the actors will sometimes need to do things differently than they rehearsed, or differently than the stand-ins did it. During the final rehearsal, the DP will often see a problem that needs to be addressed before shooting. When time seems like a luxury the director cannot afford, it is far better and faster to block quickly, light quickly, rehearse quickly, tweak quickly and shoot, than it is to shoot now and ask questions after.

CHAPTER

Preproduction planning: The package, expendables, personal tools

2

PREPRODUCTION PLANNING

During preproduction, the gaffer, rigging gaffer, and best boy meet with the DP and scout locations and sets, with the primary objective of compiling equipment lists and estimating manpower. Everything that will be needed to light the sets and locations needs to be set down on paper so that equipment vendors may prepare price quotes. The lighting order always represents a major expense to the production, so the UPM is eager to see the equipment list as early as possible in order to solidify deals with vendors and know where the budget stands.

To come up with a complete equipment list, the gaffer needs pretty clear ideas about how each scene will be lit. The gaffer reads the script carefully, making notations and raising questions for the DP. He or she discusses scenes with the DP. The input of the director, production designer, and costume designer often steer important lighting decisions. When scouting the locations and looking at the sets, the DP, gaffer, key grip, and rigging keys (rigging gaffer and rigging key grip) are confronted with the particular challenges they'll need to address: how lighting effects will be created, how lights or lighting platforms will be rigged, what control systems will be required, what colors will be used, and what special accessories are needed. These determinations translate into the specific lights and equipment needed, how much power, how much cable, and so on.

Each step of the way, the gaffer and rigging gaffer must consider three things: equipment, personnel, and time.

Equipment: What basic equipment will the lighting department carry for the duration of the show (the *truck package*)? Which scenes require additional equipment (e.g., a set with a big backing or green screen) or special equipment (aerial lifts, wet locations protection, specialty lighting equipment, and so on)? Will the transportation department need to furnish extra vehicles on particular days to move equipment from place to place?

Personnel: How many additional lighting technicians are needed to operate this special equipment (Condor, follow spot) or to prerig or wrap out cabling and equipment? Are certain days on the schedule particularly difficult, or will large locations require extra hands?

Time: What prerigging is required to achieve efficiency during shooting? How much time does it take to get into and wrap out of each set? What might cause lighting delays? What workable solutions can the gaffer suggest?

Additionally, the gaffer and DP, in collaboration with the production designer, determine what special considerations should be given to the lighting in designing the sets. Designers are generally very conscious of lighting and design the sets with windows in places that will make for good lighting;

however, looking over the designer's plans allows the DP, gaffer, and key grip to consider practical matters such as access to the set, placement of wild walls (walls that can be removed), and removable ceiling pieces. Thinking about these things beforehand saves time during shooting.

The gaffer and DP discuss how they will approach the material: the mood and style of the film, the color palette, the working light levels, and the kind of shots. If a Steadicam shot will reveal every corner of a room, that will require all lights be hung above or outside the set, for example.

Scouting locations

The director, assistant director, and department heads scout each location in a group; the director and first AD present an overview of how the scenes are played out. The DP and gaffer formulate a rough idea of how they will light each space. If the lighting is complex, notes from the scout will be drawn up as light plots. Notes are invaluable during future discussions. The gaffer, best boy, and rigging gaffer consider the special rigging required, special equipment required, location of the staging area, and placement of the production van. During the scout, they gather the information they will need to adapt the space for lighting. For the rigging gaffer, the scout is their brief opportunity to determine most of the parameters of the job. They need to map out routes of access to each set for cabling and figure out where the generator can be placed to be as close to the set as possible without causing sound problems. They must learn from the DP, AD, and director how the feeder cables can be run to the set without entering into the shots. He needs to note other equipment such as aerial lifts or parallels that may be employed outside the windows to support large lights. The rigging grip will note required grip support like wall spreaders, trusses and windows, which may need to be gelled or blacked out.

If house circuits may be used, the best boy locates and examines the breaker box to determine its capacity and the layout of circuits. He locates the light switches for sconces and house lights. He works with the location manager and the contact at the location to gain access to locked rooms or arrange for lights to be placed on a neighboring property. He must find the service entrance through which to bring in carts and equipment without encountering stairs. He must locate the elevators. If large numbers of fluorescent lights are needed, he must get a count of the number of tubes to be ordered. In short, he must fully think through the lighting needs at each location. The rigging gaffer has a lot to do on the scout and is always the last person back on the bus.

An iPad and some good software can be invaluable for noting and processing the requirements of each location. Apps like *TechScout Touch* are designed to streamline the process of compiling the equipment order and communicating it with the gaffer, DP, and production office. Once the locations have been scouted, the rigging gaffer or best boy looks over the production schedule; evaluates personnel, equipment, and time requirements; and writes up an equipment list, an expendable supply list, and a calendar showing when special equipment and additional labor will be needed. A form like the one shown in Table 2.1 is extremely helpful for remembering and determining the needs of each location.

Production meetings

At least one major production meeting is held before production begins. This is scheduled after all the tech scouts have been completed and is attended by all the department heads. The meeting is led by the first assistant director. Typically, the AD goes through the script scene by scene and describes all the major elements. Questions and concerns from any department are raised and discussed. Issues that involve a great deal of interdepartmental cooperation are the most important to flush out in detail.

Weekly Schedule of Personnel and Equipment								
Personnel Schedule		**Week of Production**						
	Totals (days)	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*
1st Unit Location:								
1st Unit Move to:								
Programmer								
Extra lamp operators								
Rig gaffer								
Rig location 1:								
Rig location 2:								
Strike location 1:								
Strike location 2:								
Fixtures person								
Total riggers								
Equipment and Coordination Schedule		**Week of Production**						
		Day, Date	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*	*Day, Date*
TRANSPORTATION								
Crew cab/stake bed								
Trailer								
Scissor lift								
Condor								
Tow Plant								
Notes								
LOCATIONS								
(Notes, e.g., kill streetlights)								
SPECIAL EQUIPMENT								
(e.g., balloon lights, Bee-Bee lights, equipment drop load, details, equipment pick up, etc.)								
NOTES								
(e.g., rig lifts, change out fluorescents, load-in 1st unit, etc.)								

Decisions involving only two parties can be identified and deferred to separate meetings. The gaffer and key grip are required to attend, listen, and contribute when it is helpful. This is usually a long and painful meeting, but it is often the only opportunity for everyone to learn about the plans and needs of other departments that might affect them.

Wireless spectrum management meeting

As discussed in Chapter 12, the wireless spectrum is a crowded space. If lighting is to be controlled wirelessly at any point during production, it is essential to establish interdepartmental cooperation and manage the use of the spectrum. This starts by holding a dedicated preproduction meeting that includes camera, sound, lighting and anyone else depending on wireless equipment.

It may be helpful to perform a site survey/spectrum analysis of the locations prior to the meeting to see what interference/traffic exists already; however, the radio environment is never static and a sample at one time might not be representative of the environment at all times. It is desirable, especially on studio lots with multiple concurrent and changing productions, that a person from the facility with knowledge about adjacent and potentially new incoming productions is present.

The meeting should be structured to accomplish the following:

- Submit each department's equipment specs, spectrum needs, and capabilities. It is each department's responsibility to obtain as much information as possible, ideally from the manufacturer (see sidebar).
- Determine what measures will be taken to ensure mission-critical channels are not stepped on, such as the following:
  - assignment of distinct channels so they do not overlap (for example, on the 2.4 GHz spectrum, channels 1, 3, and 11 do not overlap),
  - verification that video transmitters are 5 GHz and not 2.4 GHz (new equipment from Teradek, Paralinx, ARRI W, and Amimon use 5 GHz band),
  - use of frequency blocking (a setting on the transmitter that blocks it from certain channels),
  - use of reduced power level settings,
  - selection of antenna type and location, and
  - use of wired connections where needed.

RADIO EQUIPMENT SPECIFICATIONS RELEVANT TO SPECTRUM MANAGEMENT

- Brand, manufacturer, product ID
- Firmware version
- Equipment category (e.g., lighting control DMX/RDM transmitter)
- Operating frequency (e.g., 2402–2480 MHz)
- RF technology (e.g., narrow band, adaptive frequency hopping spread spectrum)
- Modulation
- Directionality
- Channel width and spacing
- User frequency management capability (e.g., multiple 20 MHz wide channel blocking)
- On-air duty cycle
- FCC maximum peak output power
- User output power management capability (selectable power levels in dB and mW)
- Antenna (gain and directionality)
- EIRP (Effective Isotropic Radiated Power) (dB)

THE LOAD-IN

The load-in is the first day of work for the lighting technicians on a feature film. The best boy supervises the checkout and load-in, making sure the lighting order is correctly filled and all the equipment is in full working order. The checkout must be extremely thorough. Even at the best rental houses and studio lamp docks, you cannot assume that all the equipment is in perfect working order or leave the counting to someone else. At the completion of filming, any broken or missing items are charged to the production as "lost and damaged." There are a lot of ways to foul up the paperwork: orders are often changed at the last minute, and special equipment may come from more than one rental house. Almost always, a few items require maintenance or are miscounted by the rental house, so count and check the equipment carefully.

Prepping lights and stands

Each light should be inspected for physical damage and tested by turning the light on and testing each of its functions at checkout. Once you establish a routine for checking lights, it takes very little time to check all the items on the checklist.

For lights like LEDs, that will be controlled from the console, the programmer determines which one of the light's DMX profiles will be assigned and then creates a patch sheet for all the lights that are on the console. The patch tells you the fixture number, universe number, and DMX start address for each light (see Chapter 12 for full explanation). During the prep each light should be labeled with this information, with the fixture number in large, bold, clear numbers. The label might look something like this:

S60 2			
Mode	**Fixture**	Uni	DMX
P25	**1202**	1	174

LUSTR 2			
Mode	**Fixture**	Uni	DMX
HSIC+7	**1092**	1	120

Start by performing a factory reset to dump anything that is in memory and set the light back to all its default settings. Check and update the firmware as needed. Set DMX start address and DMX mode/profile. If there are other custom settings like Hold Last Look or Low End Mode, use a checklist to be sure all the settings are made correctly on each light. See Chapter 7 for an example of a SkyPanel Setup checklist. If the light is RDM compatible settings can be made very easily using DMXcat® or directly from the console (see Chapter 12).

For tungsten and HMI lights and stands see Checklists 2.1 through 2.3. Take your time; you do not want to discover problems on the set when production is in full swing.

There are times when prep time is insufficient, but the goal is to check the gear as thoroughly as time allows. If the production is traveling to location where it will be hard to replace an item, it becomes even more important to ensure everything is working 100 percent. Lack of prep is a form of risk-taking. Risks need to be brought to the attention of the UPM. If management understands the risk, they may be able to line up a plan B, even if they decide against granting more prep time. The best boy

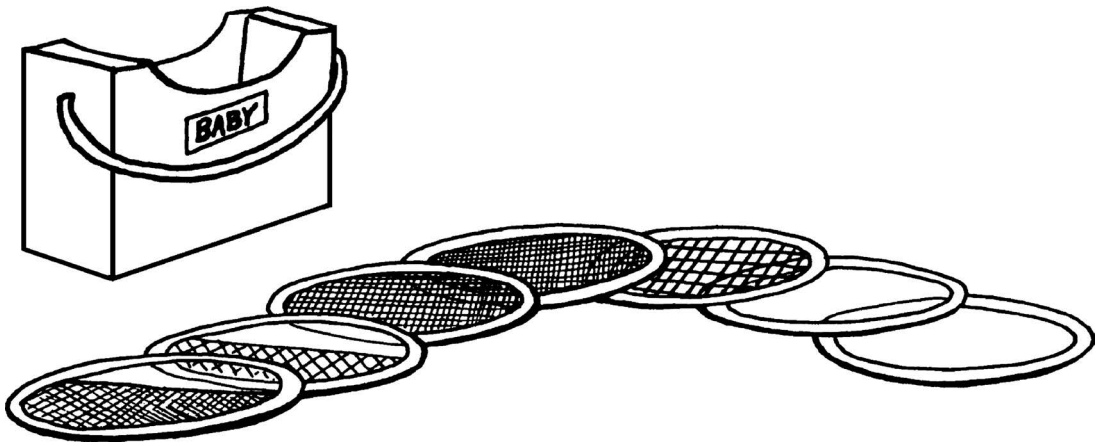

FIGURE 2.1

Complete scrim set with box. The Hollywood set includes (from left to right) a half double, half single, two doubles, a single, and a set of gel frames.

or gaffer needs to have a conversation with the production team. Generally, any situation you can't fix yourself, that creates risk that could affect schedule, cause damage, or present a safety hazard must be escalated to the producer's team.

CHECKLIST 2.1: FRESNEL AND OPEN-FACE TUNGSTEN

- □ Check that each light is complete. Each must have a full set of scrims, a scrim box or bag, and barn doors. Count the scrims. A complete five-piece set includes two doubles, one single, one half double, one half single, and one set of gel frames (Figure 2.1).
- □ Check the fit of barn doors. Check for floppy doors. For fresnels, most gaffers prefer four-leaf rather than two-leaf doors. Doors should be fitted with safety chain.
- □ With the power disconnected, open the fixture and check the condition of the reflector. Especially with hot-burning lights such as baby-babies or baby-juniors, the reflector can become warped and discolored by prolonged use tilted steeply downward. The reflector must be properly aligned, unbent, clean, and in good condition.
- □ Inspect the bulb for blisters and bulges, evidence that the bulb has been mishandled, and burnout is imminent.
- □ Check whether the lens is clean and free of cracks. A little dust buildup on the lens cuts the light output in half.
- □ Check whether the tilt lock (T-handle) threads properly. The threads sometimes get stripped.
- □ Check whether the tilt lock knuckle holds the light firmly. The cork disks at the swivel point wear out and occasionally need to be replaced.
- □ Check plugs for signs of overheating—discoloration, deformation.
- □ Plug in each fixture and turn it on to check the bulb and the switch. Wiggle the cord at the switch and lamp housing to ferret out any intermittent discontinuity (problem with power cord or lamp base contacts).
- □ Make sure that you have any needed connector adapters.
- □ Check the flood spot mechanism for smooth, full travel. Observe the beam as it changes. An uneven or odd-shaped beam is evidence of an improperly aligned bulb or a bent or damaged reflector.

CHECKLIST 2.2: ADDITIONAL STEPS FOR HMI CHECKOUT

- □ Inspect all the same items as for a tungsten light, especially inspecting the bulb for blisters and bulges and checking that the lens is clean and uncracked.
- □ Each unit should be complete with scrim set, barn doors, lens set (for PARs), two-head feeder cables, ballast, and power feeder cable.
- □ Hook up and turn on each light, using both head feeders. Inspect the head cables for bent pins or misthreaded connectors, cuts in insulation, and a loose strain relief collar at connector.
- □ Allow several minutes to reach full output. Using a spectrometer to measure the color temperature and green/magenta shift of each unit. Mark these measurements on a piece of white camera tape and tape it to the bail of the light. Also include the date and the unit number.
- □ Number each head, and globe box, so that the same head and globe are always used together. Or name them, Curly, Larry, and Moe, for example.
- □ Watch for unstable arcs. You can use a welder's glass to observe the bulb through the lens.
- □ You may also want to test the restrike capability of the light by turning it off and attempting a restrike after 15 seconds. If the light will not restrike, try again once every 60 seconds to see how long you have to wait. Note: repeated unsuccessful ignition attempts discolor the inside of the bulb; don't overdo it.

CHECKLIST 2.3: STANDS CHECKOUT

- □ Raise each stand to full extension. Check for binding and corrosion. Test the lock of each T-handle.
- □ Inspect for bent or broken braces and loose or missing brace bolts.
- □ Crank stands and motorized stands should be tested by raising and lowering the stand with a sandbag on the top. The weight is necessary to prevent the stand's inner mechanism from binding when lowered.
- □ Pneumatic tires should be fully inflated and roll smoothly.
- □ Check that the wheel swivel locks, brace hinges, and collars operate properly.

The production van

When shooting on location, the lighting crew works out of its truck. Depending on the size of the production, the vehicle may be anything from a cube van, to a 10-ton truck, or a fully customized, 40-foot, 18-wheel production van. A fully equipped production van like the one shown in Figure 2.2 is complete with dual generators mounted on the tractor. The truck has a large hydraulic lift gate on the back, one or more side doors with stairs, interior lighting, and a well-organized design. It may have some shelving for equipment and brackets on the doors to hold stands. The most efficient arrangement is to have all the most frequently used lights stored on shelved carts. For example, a big LED cart, small LED cart, tube and ribbon cart (see photos in Chapter 7), a tungsten cart, HMI cart, expendables cart, and so on (Figures 2.3–2.5). The lighting inventory can simply be rolled off the truck and straight to the staging area. Marking exactly what and how many of each item goes on the cart ensures you have everything at the end of the day. During transport, carts are strapped to the walls of the truck. Smaller 5- and 10-ton trucks have jockey boxes underneath both sides of the truck that carry cable and sandbags. Tractor-trailers have doors along the length of the belly that can hold a substantial quantity of cable and distribution equipment. Cable dollies (Figure 2.3) are used for moving cable and distribution equipment.

FIGURE 2.2

A 40-foot production van with two tractor-mounted generators.

(*Courtesy Mike Ambrose*)

FIGURE 2.3

The production van houses all the equipment for transport. Note that the head carts are loaded and strapped to the walls. Two cable carts are pictured at left. Further to the front of the truck shelving holds other lights, and supplies.

(*Courtesy Mike Ambrose*)

FIGURE 2.4

The expendables cart carries milk crates which typically store practical lamps, spare lamps, hand dimmers, tape, sash, Velcro, hardware, and so on.

(*Courtesy Mike Ambrose*)

FIGURE 2.5

Gel rolls are stored on the back side of the expendables cart. Rolls of diffusion, ND, plus and minus green, CTO, CTB, and CTS gels are typically carried.

(*Courtesy Mike Ambrose*)

EXPENDABLE SUPPLIES

Expendables are supplies that are purchased and used up in the course of production. The best boy and lighting technicians use prep days for organizing and prepping expendables, cutting gels for the lights, and completing any similar tasks to get everything ready for the first day of shooting.

Gels and diffusion

Normally, the crew will prepare precut color correction and diffusion gels to fit whatever lights may need them. Cuts of gel are kept in a crate, sectioned according to size and color (Figure 2.6). A 6-in. square fits inside the barn doors of units 1k or smaller. An 8-in. square fits studio babies and baby juniors. The 10- and 12-in. sizes fit inside the doors of regular juniors and outside the doors of lamps 650 W and smaller. The larger cuts of gel fit on the outside of the doors of 2ks, 1200 HMIs, and PAR lights. Anything larger than 24 in. can be gelled using a frame supplied by the grips.

The best way to cut gel from the roll is to use a template. Cut a 24-in. × 48-in. piece of ½-in. plywood and mark out a grid pattern in the sizes you need. Use a circular saw to score along the marks, making grooves ⅛-in. deep. Roll the gel or diffusion out on the template, aligning it to the edges and then use a matte knife to slice down the grooves. Mark the corner of each gel cut with the color, ½ CTO, or ¼ CTB, or 216 diffusion.

Electrical expendables

A production may or may not require all of the items described here. During prep, these items are organized in the drawers of a work box, crates on the milk crate cart, and boxes on the shelves of the truck. Label each drawer, crate, and box with its contents to make items easy to find. A large-capacity toolbox with drawers makes an excellent storage place for all the small expendable items (Figure 2.4).

FIGURE 2.6

Cut gel and diffusion are marked with permanent marker and stored according to size and type. Here, short sections of PVC pipe create a convenient gel organizer.

(*Courtesy Mike Ambrose*)

Common expendables

Tape rolls: Put together a selection of tape rolls on a loop of sash cord: one roll each of 2-in. gaffer's tape, 2-in. black paper tape, and 1-in. white cloth tape. The electrical tape rolls (all colors) go together on a separate rope.
Practical bulbs: Mark and organize practical bulbs so their wattages and types are easily readable. Label the boxes. Insert foamcore dividers in a couple of milk crates. Stock compartments with various types and wattages to keep near the set. PH-bulbs (211, 212, and 213) do not have their rating printed on the top of the bulb. It is helpful to mark the top of these bulbs with a permanent marker: one dot for 211, two dots for 212, and three dots for 213.
Black wrap: Black wrap is a durable black foil used on hot lights to control spill and shape the beam. It is available in rolls of 12 in. (50 ft.), 24 in., and 36 in. (25 ft.). White wrap is also available.
Clothespins: Nicknamed C-47s or bullets, these are used to attach gels and diffusion to the lights.
Binder clips: (the metal spring-loaded oversized paperclips) are also handy for attaching gels and fabricated snoots.
Rubber matting: Matting is used to cover power cables where they cross doorways and other traffic areas. It comes in rolls 24 in. wide, up to 100 ft. long.
Sash cord: Sash cord is made of white cotton rope. It is used for tying cable to pipe, among other things. Commonly used weights are #6, #8, and #10.
Trick line and mason line: These are #4-weight nonstretch rope. Trick line is black. Mason line is white. Used for tie strings for smaller cords and data cables.
Bungee cords and S-hooks: Black rubber bungee cords come in various sizes and should be ordered to fit the shelves of the truck and carts.
Cube taps: Cube taps are used for plugging several low-amperage lights into one outlet (15 A max). See Figure 2.7.

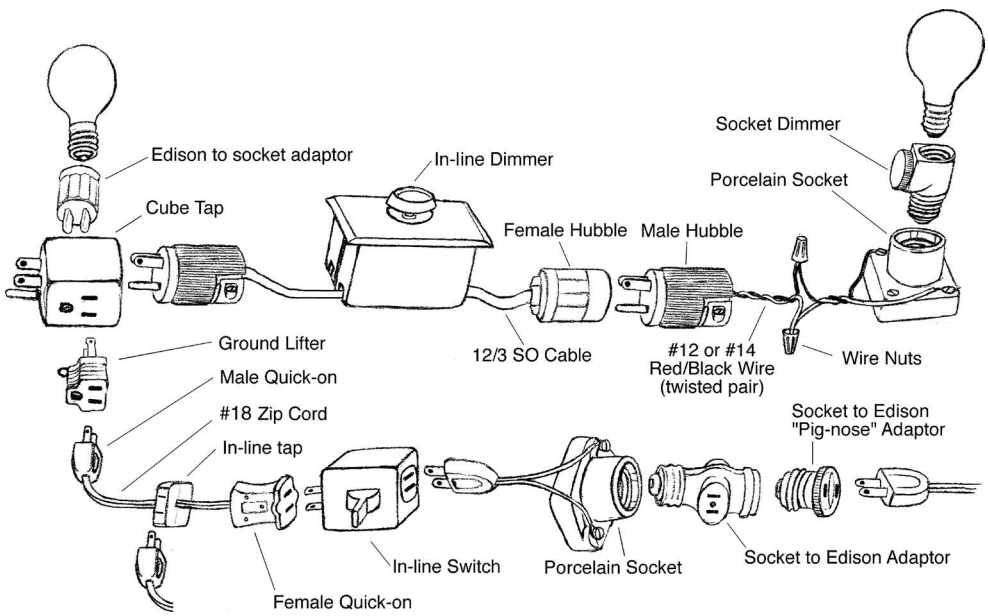

FIGURE 2.7

Electrical supplies.

Ground plug adapter: A ground plug adapter is used to adapt grounded plugs to the ungrounded outlets found in older buildings. It is also called a *cheater*, *ground lifter*, or *two-to-three adapter*. See Figure 2.7.
Quick-on plugs: These are small, low-amperage Edison sockets and plugs that can be connected to #18 zip cord quickly with no tools. Quick-on plugs can be used on small practical lamps. See Figure 2.7.
Zip cord: Light 18-gauge household lamp cord used for wiring small practical lights. See Figure 2.7. Part 530 of the National Electrical Code (NEC) requires that all cords and cables used for set lighting be hard usage or extra hard usage cables. Zip cord does not meet this requirement, so therefore quick-on plugs, add-a-taps, in-line taps, and zip cord are not approved for lighting devices except where the cord is part of an approved assembly like the cord of a table lamp.
Wire nuts: A wire nut is an insulated cap used to splice two bare wires together. See Figure 2.7.
Dimmers: Household dimmers of 600 and 1000 W are commonly used to dim small lights and practicals. See Figure 2.7.
Porcelain sockets: Lamp sockets (medium screw base, E26) are used to mount lightbulbs in set pieces and soft boxes. Use porcelain sockets, because photo bulbs will melt plastic sockets. See Figure 2.7.
Socket dimmers: A socket dimmer (150 W max) screws in between the lamp socket and the lightbulb, allowing the bulb to be dimmed. See Figure 2.7.
In-line switches: When rigging practical lights in sets, it is sometimes handy to have a plug-in 15-A switch on the line. See Figure 2.7.
Hubble Edison: Stock male and female Hubble Edison plugs to replace the plugs on stingers and power cords when they burn out. See Figure 2.7.
#12 copper wire: Black, white, and green #12 wire for wiring special lights and devices. See Figure 2.7.
Spare fuses: Consider having replacement fuses for any equipment that uses a fuse. Gang boxes use 20-A BAF bus fuses. Sometimes 100-A to two 60-A Bates splitters use 60-A inline fuses. Variacs, ballasts, and other power supplies may also have a fuse.
Electrical tape: Electrical tape is used for color coding cables (red, white, blue, black, and green). It's also handy for insulating wire splices.
Gaffer's tape: Gaffer's tape is a heavy 2-in. fabric tape that rips cleanly in the direction of the weave. It is stronger, more durable, and more adhesive than paper tape.
Paper tape: Black 2-in. paper tape is handy for masking light. It has less of a tendency to pull the paint off walls than gaffer's tape.
White and colored cloth tape: This 1-in. and 2-in. cloth tape is used for labeling and color coding equipment.
Sharpie markers: For labeling.
Ball point pens: For paperwork and labeling.
Snot tape: (3M transfer tape) This is a sticky film that is handy for mounting gels in gel frames.
Zip ties: For bundling cords or securing items to one another.
Velcro and Velcro adhesive tape: For tying cords and cables and securing items to one another.
Dulling spray: This is a spray applied to shiny surfaces to tone down reflective glints.
Streaks and tips: Colored hair spray is used to tone down or black out surfaces that are too bright. It is water-soluble, washes off easily after filming, and comes in shades of auburn, beige, black, blond, brown, gray, pink, silver, white, and others.
Practical bulbs: These are bulbs used in practical lamps, usually household (medium screw base) bulbs. Various types are used, among them photoflood bulbs, household bulbs, floodlights, spotlights, and small fluorescents. See Appendix B.
Fluorescent bulbs: High color rendering index (CRI) tubes replace fluorescent tubes in offices and commercial buildings where the existing fluorescents are not correct for photography. In large quantities these may also be rented.
Flashlight bulbs: Replacement bulbs for lighting technicians' flashlights.

Batteries: Use AA for flashlights; AAA for light meters; disk batteries for voltage/continuity meters; and 9 V for amp probe and light meters.
Cotter pins: Cotter pins are used when hanging lights to prevent the receptacle from slipping off the pin.
Visqueen heavy plastic sheet: A Visqueen heavy plastic sheet is used to protect equipment and electrical connections from rain, precipitation, dew, dust, and sand. It comes in 100-ft. rolls, 20 ft. wide (folded to 5 ft.).
Crutch tips: Crutch tips are put on the legs of stands to protect floors, in sizes of ¾ in. for small stands and 1 in. for large stands.
Refracil: Refracil is a heat-resistant cloth that will not burn when a hot light is placed on it. It protects ceiling and wall surfaces from heat damage.

TOOLS AND PERSONAL GEAR

Tool belt

When working on set, a lamp operator carries the needed tools and supplies on a tool belt (Figure 2.8) in a compartmentalized pouch. A flap folds over the tools to prevent them from falling out. Sharp tools (such as a knife) and delicate instruments (such as a voltmeter) are best stowed out of harm's way in their own protective leather pouches. Spread the weight around the belt to avoid putting stress on your back. Some lighting technicians try to carry everything but the kitchen sink on their belts. They have tools hanging, clanking, and jangling from every part of their outfits. What you choose to carry varies depending on the circumstances. Keep in mind that all the gear you buy for work is tax-deductible. Save your receipts! Some of the following are illustrated in Figure 2.9.

FIGURE 2.8

Tool belt.

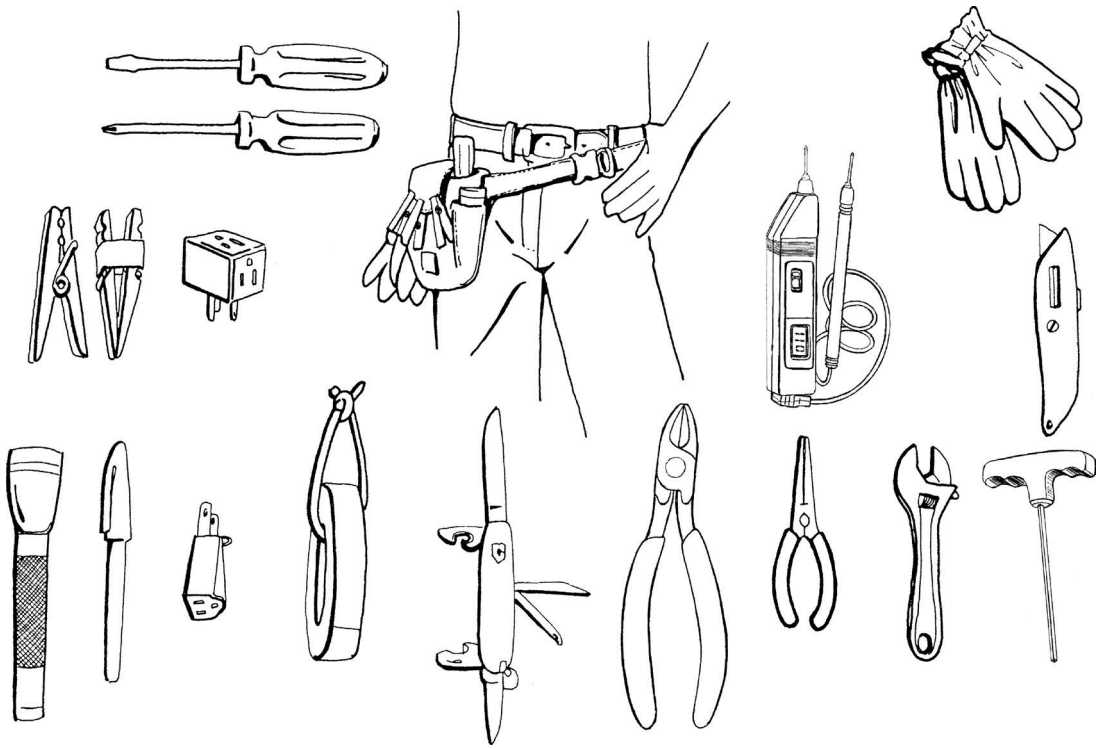

FIGURE 2.9

Tools and supplies.

Leather work gloves (or equivalent): Made of cowhide or some equivalent, these are used for handling hot lights or dirty cable and hardware. Clip them onto your belt when you are not wearing them. Leather gloves protect your hands from heat, abrasion, and grime. They cannot necessarily be counted on to protect you from electrical shock. Although they may provide electrical insulation when clean and dry, typically they are wet with sweat, making them a conductor.
Glove clip: A glove clip loops over a belt and provides a small spring clamp to hold gloves.
Screwdriver: Carry a screwdriver with a reversible tip—flathead on one side, Phillips on the other.
Utility knife with retractable blade: Knives are used for cutting gels, foamcore, rope, and so on.
Scissors: Small, sharp scissors are often handy for making more careful cuts of gels and the like.
Wire snips: These are used primarily for cutting wire for practical lamps and making wire splices but have other important uses (discussed later in this book).
Crescent wrench: An adjustable wrench is used to tighten a pipe clamp, adjust the friction of a bail, and perform countless other jobs. The standard 6-in. crescent wrench has a ½-in. maximum jaw opening that is too small to fit the ⅝-in. bolt used on many pipe hangers. You can find 6-in. crescent wrenches with an extra wide jaw, which are ideal, or carry an 8-in. wrench, which is bulkier.

Needle-nose pliers: Needle-nose pliers are used for pulling hot scrims out of a light and for wiring.
Bates cable tool: This tool performs three functions necessary for maintaining Bates connectors. It has a pin-cleaner, pin-straightener, and pin-splitter. It comes in its own pouch.
Voltmeter/continuity tester: A voltmeter/continuity tester is used to check line voltage (120, 208, or 240 V), check for voltage drop, and locate broken connections in power cords. A continuity tester tests for burnt-out bulbs and fuses and continuity in wires. Some models have a pushbutton on/off switch, which helps prevent inadvertently running down the batteries.
Circuit tester: Plugs into an Edison outlet and tells you whether the line is hot. Also indicates whether the polarity and grounding are correct.
Line sensor (voltage tick): A *non-contact voltage sensor* indicates whether a wire has current flowing through it by sensing the magnetic field.
Flashlight: Lighting technicians frequently find themselves working in the dark. When dealing with electricity, you always need to see what you are doing. Small, rugged, focusable flashlights are easy to carry on your belt.
Clothespins: For attaching gel and diffusion to barn doors. When using gel, keep several on your belt. Figure 2.9 shows an inverted C-47 (a C-74), which is handy to pull hot scrims out of lights.
Permanent marker: This is used for labeling gels, fixtures, connectors, and cables.
Ballpoint pen: A pen is used for taking notes, filling out paperwork, and taking down phone numbers.
Cube taps: Keep a supply of two or three on you.

Meters

More sophisticated electrical measuring equipment may be useful to a best boy, generator operator, rigging gaffer, or dimmer board operator. These meters are used for troubleshooting and close monitoring of the power supply and electrical system. Electrical meters are covered in detail in Chapter 17. Useful meters include an Amp Probe, Digital Multimeter. DMX512 testers and Soco testers are covered in Chapter 12.

Other hand tools

Some supplemental tools can make life easier. These are usually part of the gaffer's kit, kept in a workbox in the truck.

Automatic wire stripper: This tool provides a fast, precise way to strip insulation off the ends of wires. It is handy when wiring a lot of fixtures.
Rope wrench: This heavy-duty snip can cut cable or rope cleanly. It saves a lot of time and aggravation when making up stingers, wiring fixtures, or rigging with rope.
Crimper: These are used for crimping connectors onto wires, useful when wiring some types of fixtures.
T-handle Allen or spider wrench: Some old facilities may still use some equipment that has copper bus bars to which feeder cable are bolted with sister-lug connectors. A T-handle Allen wrench is used to tighten and loosen sister-lugs. A spider wrench is one that fits over the outside of the sister-lug bolt. It is handy when an Allen slot gets stripped.
Lighting technician's scissors: These extra-tough scissors (they can cut through a penny) are especially useful for cutting metal gobo patterns, but also great for cutting gels, rope, and the like. (A gobo is a metal cutout used to make patterns in light).

Hand rasp (also called a rat-tail rasp): This rasp can pierce and saw through luan (the thin plywood used to make set walls). It is useful for cutting a quick rat hole in a set wall, to feed a power cord into the set.
Ratchet and socket set: Makes fast work of tightening and loosening bolts.
Allen wrench sets or hex set (English and metric): These wrenches are used for fixing stands, among other things.
Full set of screwdrivers: The set should include a large and small Phillips, a very small flat-head screwdriver, a large flathead screwdriver, and a right-angle screwdriver for lamp head repairs.
Vice grips: These include small, needle-nose grips for clamping onto small parts while making repairs and large, crescent vice grips for getting a tight grip in a jammed pin connector.
Soldering iron and materials: Mainly used for soldering LED ribbon. See Chapter 7 for more on soldering ribbon.
Cordless electric drill/screw gun: Especially useful when rigging, a screw gun is handy to affix devices to a wooden structure to keep them neat and organized.
Hammer: For hammering or pulling nails (more commonly a job for construction or grip department).
Steel tape measure: For dimensioning construction projects.
Glue: Super-glue has a multitude of uses.
Large flashlights: It is handy to have some big flashlights when shooting at night. They can be passed out to lighting technicians at the end of the night to perform a walk-around "idiot check."
Can handle: This is a handle that fits over the bull switch to provide comfort and leverage when throwing large, spring-loaded switches. If you throw a lot of switches, a handle can save you a lot of strain.

Personal gear

Lighting technicians get dirty. Jeans, a t-shirt, and work boots or sneakers are normal apparel. Weather permitting, it is advisable to be prepared to protect your legs and arms with long pants and a long sleeve shirt. Be prepared for the weather. In southern California you might need only sunscreen, a baseball hat, sunglasses, and a jacket and jeans for after sunset, but be prepared for all weather conditions. You'll want to keep the following personal gear in your duffel bag:

- A full rain suit.
- Rain boots.
- Cold-weather jacket, hat and gloves.
- A change of clothes in case you get wet, especially socks and a t-shirt.
- Consider the terrain. Hiking boots or work boots are often desirable.
- Sunscreen.
- Lip ointment.
- Mosquito repellent.
- Ear protection (disposable earplugs or head gear for when firearms are used).
- Eye protection (goggles or safety glasses). The special effects department usually supplies ear and eye protection to everyone who is needed near the action during explosions and stunts.
- Goggles and a bandana are needed when working in the desert. Blowing sand gets in your eyes, nose, and mouth and can practically blind you.

CHAPTER

Lighting objectives

3

Before we start getting into all the gear, let's take a step back for a minute and think about the objectives of lighting in a film, TV show, or commercial. For the film director and cinematographer, the lighting is part of the fabric of the story and how it is told. It contributes to the mood of each scene. The lighting locates the scene in time and space. Light is an important compositional element that leads the eye around the image, separates people from backgrounds, creates depth, and communicates ideas graphically. The first part of this chapter focuses on these story-based lighting objectives.

The cinematographer meets these story-based objectives by controlling a variety of photographic parameters: light level, exposure, contrast, depth of field, frame rate, shutter angle, and so on. In the second part of this chapter we will discuss the tools used for measuring light and evaluating the video signal.

STORYTELLING OBJECTIVES

The look of a show may be gritty and hyper-realistic, slick and clean, high-tech and stylish, or lush and glamorous. It may be naturalistic or it may be stylized or theatrical. In this section, we'll look at three important elements that contribute to the look and style of a production through lighting: mood, naturalism, and composition.

Mood

Mood is perhaps the most powerful contribution of lighting to a motion picture. Lighting is expressive. It can set a tone for a scene and even reveal hints about the characters. Light can connect a character to her surroundings, or it can isolate her. A person may be surrounded by glowing human faces or anonymous figures. Lighting can also inform character by showing how a character treats light in the story. Would she invite sunlight to pour into the room, or close it out, leaving us in a dark space, with the sunlight seeping around the edges of thick curtains?

Lighting can trace the arc of a story, so spaces change in appearance and feel from one part of the film to the next. The arc may be a long day's journey into night, or an emergence from darkness into light. Motivating light sources have different associations—a blinking sign, a crappy fluorescent, a sunset, a blue computer screen, a glaring car headlight. Separate from the environment, the way an actor is lit affects how the audience experiences the character—radiant with charisma, frazzled and imperfect, strong and determined, and so on. These details may be dictated by the script or merely

suggested by the tone of the scene. The color and quality of light may influence the audience's perception of a character's inner emotional state, but it can also be ironic—a miserable lonely person faced with a beautiful sunny day. Or it can just be realistic, unmelodramatic, and neutral.

Naturalism

The quality, color, and direction of the light and the sources it implies are part of what makes a scene convincing. Often unconsciously, the lighting instantly clues the audience to the setting, the type of space, the time of day, the season, and even the weather and the atmosphere of the place. Like a good novel, these natural occurrences are cues that may also contribute to mood, but realism itself gives the images truthfulness, and makes the storytelling more compelling and believable. To create natural-looking lighting and keep things consistent, the lighting crew has to control the existing light sources and recreate realistic, natural lighting using artificial sources.

The opposite of natural lighting is lighting that *gives away* the artificial setting to the audience: when the camera records multiple shadows cast on the walls and floor by an actor, when one can trace the diverging rays of light back to a lamp outside a window, when a shot shows "direct sunlight" coming into a room from two opposite directions or at different angles at each window.

Composition

Lighting is used as a means of emphasis and delineation. It helps separate the layers of the three-dimensional world on a flat, two-dimensional screen. It can also create purely graphic effects that contribute to the composition.

The DP selectively emphasizes characters or elements, letting the lighting direct the eye within the frame. For example, imagine a wide shot looking down over the congregation in a large church. The shot immediately conveys the grandeur of the ceremony, but without further help, our eye wanders without a focus. An increased light level surrounding the figures at the front of the church draws the eye to our focal point of the scene, the couple making their vows at the altar. The light falls off on peripheral figures.

When the three-dimensional world is telescoped onto a sensor (or celluloid) and projected onto a flat screen, objects do not stand out from one another. When foreground and background share the same value, they blend together. The cinematographer can reemphasize depth in the image by accentuating the outlines of people and objects, using backlight to create an edge or rim light. Backlight has long been an accepted convention in movies and TV; however, a glamorous backlight can also appear artificial. Motivating the light with some sense of source helps make it look natural. A bright window in the background, for example, could motive a bright edge light.

Backlight is not the only way to create separation. The cinematographer might choose to separate the foreground, middle ground, and background simply by lighting them to contrasting levels of brightness. He or she can line up a highlight in the background so that the dark side of the actor's face is against a light background, like a shaft of sunlight through the atmosphere, a pool of light around a practical, or a slash of light across some wall art.

Another important compositional element is depth. A composition that includes surfaces at various distances receding into the distance increases the shot's sense of perspective and scale. If the shot includes some sense of space beyond the plane of the facing wall, outside a window or through an

open doorway into other rooms, the gaffer can create planes of light and dark that recede deep into the picture. Depth offers nice opportunities for interesting lighting and composition.

A DP can break up a boring block of wall by lighting it with graphic shapes or lines. This could be done by throwing a diagonal slash across the background, a pattern of moving foliage, a window frame, a Venetian blind, or by using objects in the set dressing to create irregular shadows. Lighting a textured surface at an oblique angle emphasizes the texture of the surface. The wall of a corrugated metal building appears as a pattern of vertical lines, a brick wall becomes a pattern of regular rectangles. Breaking up the background with textured light goes a long way toward creating an exciting image from one that would otherwise be flat.

Time constraints

An additional objective that has been conveniently ignored thus far is working within the time frame permitted by the production schedule. In an ideal world, the DP could devote planning and attention to every detail, and the crew would have all the time needed to rig and tweak the lighting. In real life, however, speed often becomes the top priority, and the lighting has to be designed accordingly. Sometimes it feels like we only have enough time to eliminate the really horrible problems, and once that's done, we shoot. The lighting crew spends all its energy trying to get out of the fire and back into the frying pan. Nonetheless, even under the worst of circumstances, the DP and lighting crew aspire to arrive at an image that is more than merely acceptable, but in some way evocative, and sometimes even striking and memorable.

PHOTOGRAPHIC OBJECTIVES

A film without sound is a silent movie. A film without light is radio. Obviously, you must have light to expose the image. But more than that, much of the artistry of cinematography is in the control of exposure and contrast, selectively exposing objects and characters to appear bright, slightly shaded, darkly shaded, barely visible, or completely lost in darkness, as desired. The contrast between the dark side of a person's face and the light side, changes the mood of the image. In this section we'll explore light levels, exposure, and contrast, and the tools we use to measure these things.

Light level

A single parameter that affects all a gaffer's major decisions is the needed light level. Light intensity is measured in foot-candles (fc)[1] using an incident light meter such as the digital Spectra Professional IV (Figure 3.1). A reading expressed in foot-candles is independent of the variables that affect exposure, like ISO, shutter angle, shutter speed/frame rate, and filtration.

[1] One foot-candle is one lumen per square foot. Lumens (lm) are a measure of the total visible light emitted by a source. A foot-candle is a measure of how much of that light lands on an object some distance from that source. Lux is another unit used to measure the same thing. Unlike foot-candles, lux units are part of the international system of units of measure (SI). One lux represents one lumen per square meter. One foot-candle equals 10.764 lux.

FIGURE 3.1

Spectra Professional IV digital/analog light meter. This meter reads incident light directly in f-stops and photographic luminance in foot-candles or lux, with a range of 0.1–70,000 fc.

(*Courtesy Spectra Cine, Inc., Burbank, CA.*)

One DP I worked with many years ago shot all his films on 50 ISO film stock at an f/4 or f/5.6, indoors or out, requiring a light level of 400–600 foot-candles. To do this requires many large HMI units, heavy 4/0 cable, many large power plants, and lots of hard-working technicians.

Today, a typical ISO rating of a digital camera is 800, and there are cameras rated much higher. Shooting at 800 ISO requires just 25 foot-candles of illumination to achieve an f/4. The biggest light needed could be a 100 W LED. The choice of light level affects everything: what lights to order, the power requirements, and the time and personnel needed. The ISO affects the look of the lighting. For example, using a 200 ISO film stock for an interior scene requires a fairly drastic increase in light level, virtually replacing natural light with brighter artificial sources. The large lights must very often be hung above the set, limiting realistic lighting angles. In contrast, a camera at 800 ISO requires one-quarter of that amount of light, enabling a more subdued lighting approach. Smaller lights are easier to hide, allowing more realistic angles for the light. The cinematographer can use existing light to a greater extent.

Foot-candles

Figure 3.2 shows the foot-candle scale. Each major division indicates a doubling of the amount of light, a one-stop increase in exposure. The advantage of working in foot-candles (fc) rather than f-stops is that a gaffer knows (or very quickly learns) how many foot-candles to expect from a given light at a given distance (Table 3.1 lists some approximate data; Table A.3 is a more comprehensive list). If lighting to a given fc level, the gaffer will always call for the right light for the job. F-stops, on the other hand, do not correspond directly with light level. It is not as straightforward to know what light fixture will give a particular f-stop.

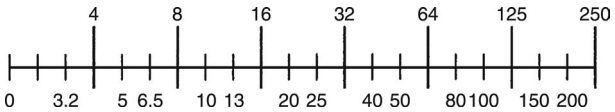

FIGURE 3.2

Foot-candle scale. Major ticks show one-stop increments. Notice, foot-candles double with an increase of one stop.

Table 3.1 Relative strengths of various sources

SOURCE	FC SPOT	FC FLOOD
Direct sunlight		6400–8000
Skylight on an overcast day		450–1800
12k HMI at 30 ft.	8250	500
9-lite PAR 64 at 30 ft.	NS lens 3600	WF lens 450
2500 HMI PAR at 30 ft.	NS lens 2880	WF lens 247
4000 HMI Fresnel at 30 ft.	2305	247
10k at 30 ft.	2465	460
5k baby senior at 30 ft.	655	110
PAR 64 at 30 ft.	VNS lens 560	MF lens 150
2k junior at 20 ft.	1000	130
SkyPanel S360-C Standard diffusion (3200) at 23 ft.		96
SkyPanel 60-C Standard diffusion (3200K) at 16.4 ft.		42
1k baby at 20 ft.	440	45
2k zip soft light at 10 ft.		100
650 pepper at 10 ft.	528	110
750 soft at 10 ft.		30
200 mini at 10 ft.	195	25
100 pepper at 10 ft.	55	23

F-stops and T-stops

The f-stop is the aperture set on the lens of the camera. The lower the f-stop, the larger the aperture, the more light passes through the lens. The f-stop increments are 1, 1.4, 2, 2.8, 4, 5.6, 8, 11, 16, and 22. Figure 3.3 shows the standard range of f-stops and the increments between f-stops.

A T-stop is what you call an f-stop when it is set on a zoom lens.[2] In this book, we will refer to exposure in f-stops. A light meter gives the f-stop by taking into account the film speed and exposure time. For normal filming at 24 fps and with a standard 180° shutter, the exposure time is 1/48th of a second.

[2] For a telephoto or zoom lens, the lens manufacturer inscribes the lens barrel in T-stops, which are f-numbers adjusted to account for the lower light transmission efficiency of these lenses. If you set a prime lens to f/4 and a zoom lens to T-4, the resulting exposure is the same; the lens compensates internally.

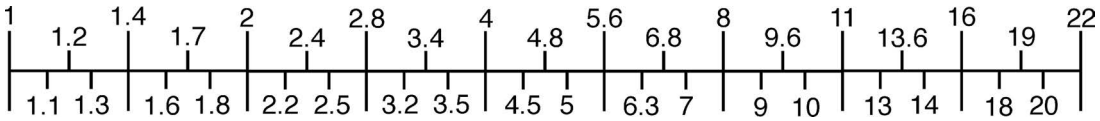

FIGURE 3.3

The f-stop scale with the actual numerical increments between f-stops.

Table 3.2 F-stops versus foot-candles for various film speeds 180 degree shutter, 24 fps

ISO	f/1.4	f/2	f/2.8	f/4	f/5.6	f/8	f/11	f/16
25	100	200	400	800	1600	3200	6400	12500
32	80	160	320	640	1250	2500	5000	10000
40	64	125	250	500	1000	2000	4000	8000
50	50	100	200	400	800	1600	3200	6400
64	40	80	160	320	640	1250	2500	5000
80	32	64	125	250	500	1000	2000	4000
100	25	50	100	5010	400	800	1600	3200
125	20	40	80	160	320	640	1250	2500
160	16	32	64	125	0500	500	1000	2000
200	13	25	50	100	200	400	800	1600
250	10	20	40	80	160	320	640	1250
320	8.0	16	32	64	125	250	500	1000
400	6.4	13	25	50	100	200	400	800
500	5.0	10	20	40	80	160	320	640
650	4.0	8.0	16	32	64	125	250	500
800	3.0	6.4	13	25	50	100	200	400
1000	2.5	5.0	10	20	40	80	160	320
1250	2.0	4.0	8.0	16	32	64	125	250
1600	1.5	3.0	6.4	13	25	50	100	200
2000	1.2	2.5	5.0	10	20	40	80	160
2500	1.0	2.0	4.0	8.0	16	32	64	125
3200	0.75	1.5	3.0	6.4	13	25	50	100
4000	0.6	1.2	2.5	5.0	10	20	40	80
5000	0.5	1.0	2.0	4.0	8.0	16	32	64

Table 3.2 correlates f-stop to foot-candle level for a variety of ISO ratings. As you can see, foot-candles double with each f-stop. For example, at ISO 500, it takes 40 fc to get a proper exposure at f/4. If we open the aperture to f/2.8 we need only half as much light, 20 fc.

Factors affecting light levels

Lens optics and camera settings introduce several factors that may require a DP and gaffer to light to a particular light level or to a particular f-stop.

Depth of field

Depth of field is the amount of depth that appears in focus. As the aperture is opened up to lower f-stops, the depth of field decreases. Depth of field also decreases the longer the focal length of the lens and the closer the distance to the subject. Telephoto lenses have shallow depth of field; wide lenses have broader depth of field for a given distance and f-stop. On a medium focal length lens, shooting "wide open"—the aperture set to the lowest f-number on the lens—only objects that are in the plane of focus appear in focus. Whereas, if you shoot at a higher f-stop, say f/5.6 or higher, objects in front and behind of the plane of focus will be less out of focus or may even appear equally sharp.

Selective focus is an important storytelling tool. The DP who wants shallow focus with a given lens needs to use a low f-stop and, therefore, needs a relatively low light level. On exterior day scenes they'll use a neutral density (ND) lens filter to avoid having to use higher f-stops. If they want lots of depth, they'll require higher light levels. A very tight, close shot on a product label of a bottle, for example, may require a very high light level to achieve sufficient depth of field to hold the entire label in focus. Thus, the depth of field also affects the size and type of lighting fixtures used to light the scene.

Other lens characteristics, like sharpness and contrast, vary slightly at different f-stops. So, DPs often prefer to shoot all the shots for a particular sequence at more or less the same f-stop. Some lenses have the greatest clarity and definition in the middle of the f-stop scale, between f/4 and f/8, so the cinematographer may ask for sufficient foot-candles to work in the center of the scale. The f-stop will also depend on the type of lens being used. Zoom lenses do not open up as far as prime lenses. A prime lens designed for speed might open up to f/1.4, whereas a long zoom may open up to a T-3.5 or T-4. That's a big difference in light level.

Shutter speed

Slow motion photography is accomplished by capturing images at frame rates greater than the speed at which the image will be shown. For example, shooting at 48 frames per second (fps) and displaying at 24 fps produces half-speed slow motion. Increasing the shutter speed reduces the exposure time, requiring more light be provided to shoot at the same f-stop.

For example, when filming a car stunt at night with multiple cameras, the working light level must be high enough to provide a workable f-stop for the cameras that are shooting at higher speeds. If the camera running at 24 fps has a correct exposure at f/4, a camera running at 120 fps would need to open up to under an f/2, requiring very fast lenses.

Slow motion, as a narrative device, is often shot at 30–120 fps, which can be achieved by many normal production cameras. Extreme slow motion, at hundreds and even thousands of frames per second, requires high-speed cameras and will involve very high light levels. Again, commercials are probably the most common situation where things need to be shot in extreme slow motion—think fizz spraying out of a can of soda, or beer filling a glass.

Shutter angle

The selection of shutter angle is another adjustment that affects exposure time and potentially light level. The "normal" shutter angle for most digital cameras is the same as film cameras, 180°. At this shutter

angle objects that move across the frame quickly will have motion blur. The cinematographer can reduce the amount of motion blur at a given frame rate by reducing the shutter angle and thereby shortening the exposure time. For example, changing the shutter angle from 180° to 45° reduces the exposure time by a factor of four. At 24 fps the exposure time is reduced from 1/48th of a second to 1/192nd of a second. To compensate and maintain the same f-stop, the light level would need to increase by 2 stops.

The formula to determine exposure time based on frame rate and shutter angle is as follows:

$$\frac{R \times 360}{A} = T$$

Where R is frame rate in frames per second, A is shutter angle in degrees, and $1/T$ is the exposure time expressed as a fraction of a second.

For example:

$$24 \text{ fps}, 45^{\circ} \text{ shutter: } \frac{24 \times 360}{45} = T \quad T = 192$$

$$\textit{Exposure time} = \frac{1}{192} \textit{ of a second}$$

$$24 \text{ fps}, 17.28^{\circ} \text{ shutter: } \frac{24 \times 360}{45} = T \quad T = 500$$

$$\textit{Exposure time} = \frac{1}{500} \textit{ of a second}$$

Some digital cameras are capable of shutter angles up to 360°, which increases the exposure time and extends the blur over a longer period of time and therefore distance. This produces an effect that is different from what people are accustomed to; however, it also eliminates the strobing effect that can happen when action moves across the frame at certain speeds, and it provides the cinematographer with an additional stop of exposure.

When shutter speed or shutter angle is not standard, everyone must be very clear when giving f-stops as to whether the f-stop compensation has been taken into account. When giving the f-stop, you would say it is an "f/4 on the lens," meaning that the compensation has been taken into account. If not, you should say you are giving an uncompensated reading, which DPs sometimes call a "base" stop. This can be helpful when the cinematographer is using multiple camera crews and the cameras are using different ISO or amounts of filtration. The DP calls the base stop, and the camera assistants adjust to compensate for their particular camera setup.

Taking readings with an incident light meter

Incident light meters measure the amount of light falling on the face of the light meter. A *hemispherical light collector*, or *photosphere* (commonly known as *the ball*), collects light from the sides, top, and bottom as well as the front. The reading is taken by holding the meter up in the position of the subject. When the ball faces the camera, the meter gives an average reading of the total amount of light falling on the subject as viewed from the camera.