3 Phase Operating Procedures

3 PHASE BASIC INFORMATION

Our Main Studio (A302) is equipped with a 3 Phase power system. This means that a much higher power draw can be serviced than when using regular mains plugs. For your protection the 3 phase system is based on a series of locks, breakers, distro boxes and two types of heavy duty weather proof connectors with heavy gauge wire. The Seeway comes in a five wire connection, and is the main feed into the 3 phase system. The five connections consist of a ground (green), neutral (white), and three hots (blue, red, black). 4AWG (gauge) cable, known as ***Fivewire,*** can carry a max load of 100A per hot safely. It is known as five wire because all five strands are loosely bundled together in one wire grouping. Five wire is available for sign out and use in the studio. 2AWG cable, or ***3 + 2*** cable, can carry a max load of 200A per hot safely. 3+2 cable comes in two separate bundles 3 wires, and 2 wires, because of its heavy weight. It is available from Whites and can provide power for more than all the lights we have a once. Calculating loads will be covered in a later chapter of this guide.

? Once a 6x50 distro box with attached Diefs has been properly set up, any student may use the Diefs as they would house mains. Plugging and unplugging lights to/from the Diefs does ***not*** require 3 phase clearance. People without clearance may not operate the breakers of the distro boxes, however, and may not plug Diefs into distro boxes.

! Studio policy for 3 phase usage is strict, and to use or modify connections on the 3 phase system students must be cleared. Students who have not been cleared caught using or tampering with the 3 phase system **will be banned from entering the studio for the remaining duration of their student career at NSCAD**.

Plugging equipment into Diefs already properly set up is safe and is exempt from this rule.

3 PHASE STEPS FOR SET UP

1. **Ensure main breaker power is off** (in down position). Leave box *off* and *locked* until *all cables are connected*.
2. Take distro box(es) (6 x 50A) and place in ideal location in studio. Ensure distro has all breakers off.
3. On main cam box attach 5 wire (this is actually in order from right to left):
    1. Connect ground (green)
    2. Connect neutral (white)
    3. Connect hots
4. At other end of 5 wire connect cams to Distro box in same order as main cam box - Green, White, Hot x 3. If using both 6x50s be sure to T off five wire.
5. Bundle excess five wire out of the way, make sure the run to the Distro box is flat and straight. When crossing areas of foot traffic with five wire be sure to cover with a rug, tape down, or otherwise secure the cabling to avoid tripping hazards.
6. Attach joy to 6x50s as needed.
7. Attach and position Dief Box(es)
8. Throw on main power
9. Turn on distro breakers for banks in use.
10. Proceed to use Diefs as you would use house mains

STEPS FOR BREAK DOWN

1. Turn on house lights. Turn off all film lights. *If you cannot safely reach the switch, turn off the downstream breaker and allow light to cool before lowering it on its stand. Fibreglass ladders are also available to rig/strike lights.*
2. Turn off and lock main breaker.
3. Disconnect 5 wire cam locks from main breaker.
4. Turn off all breakers on distro (6 x 50A) boxes.
5. Disconnect all Diefs and joy cable
6. Coil all cable properly
7. Neatly pack all electrical distribution equipment on the brown cart for storage.

GENERAL USAGE GUIDELINES

Any time joy cable needs to be removed or added to distro, turn ***off*** the breakers, make adjustments, ensure Diefs are attached, and turn the breakers back ***on*** for only the bank(s) in use. Never turn ***on*** breakers for unused banks. Ensure unused banks have breakers in ***off*** position. Main switch does NOT need to be off to disconnect, or connect joy - only the breakers of the distro box.

Lights should be balanced across the 3 phases as evenly as possible. Distro boxes have each of the 2 sets of 6 joy connectors colour coded for each of the phases (2 x 50 Amps per phase). This is especially important if both distro boxes are in use. Always keep in mind that our five wire is rated for 100A per phase. This means if both 6x50 boxes are in use and fully loaded on one phase (colour coded) the Fivewire could be overloaded.

!! Any time 5 wire needs to be adjusted, main switch must be off. !!

!! If electric crew leaves the studio, main switch must be turned off *and locked*. !!

!! Shoots caught leaving the main box ON or unlocked with no responsible party on set will be immediately shut down and all studio keys revoked! !!

CLEARANCE PROCEDURE

General 3 phase usage will be tested with students individually. Students will be tested for clearance by NSCAD Film tech support. No instruction or hints will be given at time of testing. A standardized form will be used to make sure students have understanding of complete operating procedure. Form is based on the procedure outlined above. Results will be saved in database accessible by instructors. Students will be informed of specific problems, should test result in failure.

! Failure to demonstrate full understanding of safety procedures (missing a step or doing something improperly) will result in incomplete clearance. This means the student must wait until after next class, or meeting with instructor where procedures have been covered again. Your instructor will be informed of all results, positive or negative.

? Students who demonstrate a consistent problem remembering or following safety procedures will have to use house mains instead of 3 phase cam lock system to complete projects in the studio.

Electrical Information

ELECTRICAL BASICS

Calculating electrical loads is an easy math equation:

Watts = Amps x Voltage

Here are the elements explained:

Wattage (watts) is a measure of total energy used by an electrical component, in this case a light. Most of our lights are rated by wattage, and it is usually the name by which we refer to them. A 150 (pepper) consumes 150 watts, a 300, 300 watts. The 1.2K HMI consumes 1200 watts, etc. The Kinos are one of the exceptions to this rule. They draw varying amounts of power, since each of the 4 banks can be lit independently. Each of the bulbs of a Kino uses about 165W, drawing 1.4 amps (5.5A total draw for all 4 blubs).

Amperage is the draw of electricity. This is best described as the rate of flow, similar to how a river works. At any point on a river you can measure the cubic litres of water moving past you. Amps represent the total flow of power at a given point in a circuit. All breakers are based on amperage, and rated as such. In practical terms amp rated breakers are a measure of the maximum amount of energy which can pass safely through that circuit. Common household breakers are usually 15 Amps. 20 Amp breakers are also normal for some higher draw plugs. Utility plugs, such as a stove or drier will often be ganged on two 30 amp breakers for a total power rating of 60 amps. This is the case of the utility plugs in the studio. Vintage breaker or fuse boxes may have lower amperage ratings. The bottom line is to always check the breaker box and confirm breaker values before setting up lights in a new location. Be sure to always map the plugs and know what amperage ratings you are working with.

Voltage can be thought about as the amount of force possible in a circuit, or the amount of force needed to drive an electric device. To return to the river analogy, voltage would be equivalent to the strength of the current pushing against an object (as opposed to the amount of water present). For our purposes voltage is a constant, because standard plugs, as well as the hots in a 3 phase system carry the same amount of voltage – 120V. This is a standard throughout all of North America. Other regions may have different voltages (Europe runs on 220V). All our lights, except for LED panels require 120V to run.

CALCULATING LOADS (MAINS)

Watts = Amps x Voltage

So a 120V, 15Amp (standard) circuit will be able to provide 1800 W of total power.

1800W = 15A x 120V

To figure out how many lights can plug into this one circuit (which may include more than one plug) we can add up the wattages of the individual lights. For example, two 650s and a 150 will be:

650W + 650W + 150W = 1450 W total

This would be a safe combination on one circuit, because the total wattage is less than 1800W. We cannot plug in a 2K light to a regular circuit, since it has a 2000W power usage. It must be fed from a stove or dryer receptacle.

As mentioned previously, a single breaker may have more than one set of plugs on its circuit, they may even be in different rooms. It is important to map out the circuits if doing an extensive lighting on location. In the studio the plugs have already been mapped for you, likewise in the studio it is easy to keep track of loads when using 3 phase.

CALCULATING LOADS (3 PHASE)

In the case of the distro boxes we are working with there are 6 50A breakers per box (hence the name 6x50). Remember that each hot in a Five Wire circuit can carry 100A load. The 6x50 box is split into three channels, one pair of breakers for each of the hot connections. This means each hot has two 50A breakers connected from the distro. 100A total on two breakers matches the rating of the cable, so calculating the load for each breaker is all that is required, you will not max out the cable.

Watts = Amps x Voltage

6000W = 50A x 120V

Each breaker of the 6x50 may be loaded with up to 6000W.

6000W x 6 breakers = 36,000W total system load (12000W per hot channel)

(on the 3 phase system using Five Wire)

If you were using a newer 6x60 box, then you would have to be careful not to overload the 100A Five Wire with the maximum load the 6x60 distro can handle – 120A. This might require more careful calculations, since one channel might be up to its 60A, meaning the other channel could only handle up to 40A. It is very important to double check your calculations. Running 120A total on 100A rated wire may cause the wires to overheat, potentially melting. This would be an incredibly dangerous working situation.

Likewise, if you were to T off the distro boxes and set up two 6x50s instead of just one, you are still limited to 6000W per channel, or 36000W for the whole system. You must keep track of what lights are being plugged into which channel since with two 6 x 50 distros there is the potential to have 200A running on one of the channels of the Five Wire. *This could lead to very unsafe - potentially fatal - operating conditions.*

SAFETY CONSIDERATIONS

Working with electricity is *generally safe* when devices are used as intended there are several basic rules to follow:

- Keep all lights away from sources of water. Mains + water generally equals death. This means if a light falls into a puddle, pool, or soggy ground where a person is in contact with the water, they may be electrocuted. This is doubly dangerous, because wet skin absorbs electricity more easily than dry skin. The amounts of electricity in a 15A or 20A circuit may give a shock or slight burn under dry conditions, but stop a persons heart under wet conditions.

- Film lights are generally safe to use outside in moderate precipitation. Be sure to keep power supplies off the ground (sit them on apple boxes, milk crates, etc). If you are using more than one AC cable in a run, it is preferable to seal the connection if it will be resting on the ground (plastic bag seamed with weather tight tape).

- Never circumvent breakers or fuses, especially in vintage electrical systems. Fuses and breakers exist to safely limit the amount of electricity handled by the wires leading to the plugs you are using. By removing this safety feature you may draw too much current through the wires, causing them to overheat. This overheating may lead to wires melting, sparking, or creating extreme hotspots, potentially leading to fire or electrocution.

- For similar reasons as mentioned above, be sure to use extension cables which are rated for the amount of amps being drawn through them. Avoid using lightweight household extension cables to power lights above 300W. Long runs of cables can be especially problematic. Use only film grade AC cables for runs longer than 25'. The rating of the extension cable is important because cables cause resistance to the flow of electricity – a small cable gives more resistance to higher loads than a larger one. Higher rated cables have physically larger diameters, therefore do not cause as much resistance and do not heat up as quickly or as much as smaller cables.