1.01 SUMMARY COMMENTS

A. All drives shall be:

1. PWM technology, with diode bridge front ends and IGBT transistors (IGBT) in the output section that utilize soft switching.

B. The Engineer of Record (known hereafter as the Engineer) should carefully specify drives in lab environments sensitive to radiated noise or to AC line noise. Isolation transformers or line reactors are required on all installations. Specify drives with RFI filters in areas sensitive to radiated energy. All drives shall have an adjustable carrier frequency, adjustable from 0.75 to 15kHz to eliminate audible motor noise. The drive shall be capable of operating at the maximum carrier frequency without derating the maximum current or maximum ambient temperature rating of the drive. If the drive manufacturer requires derating of the drive when running at maximum carrier frequency, then the drive size must be increased to compensate.

C. Internal drive control shall be fully digital and field programmable without external hardware.

D. The drive specification shall clearly state which equipment vendor (driven load, motor, variable speed drive) has the overall responsibility for coordinating all parts of the drive system.

E. The drives shall be fully functionally tested before shipment. The test report shall be included with the drive and also sent to the Project Engineer and Cornell University’s Project Manager.

F. The Project Engineer shall insure the drive application meets the recommendations contained in IEEE Standard 519. The building primary service entrance shall be considered the Point of Common Coupling (PCC) for establishing current harmonic limits. Total harmonic voltage distortion shall not exceed 5% at any point in the building distribution system, except in separately derived systems dedicated to the harmonic producing equipment.

G. Installation guidelines include:

1. Feed the drive directly from the main building switchboard or from a feeder that is dedicated to mechanical loads. Isolation transformers or line reactors are required on all installations. Isolation transformers or reactors shall not be in the drive circuit when operated in bypass, except in the case where a transformer is needed to change voltage.
2. All control wiring should include shielded wire and be installed in separate conduit from power wiring.
3. In applications where the drive will be more than 100 cable feet from the motor, it is the responsibility of the drive manufacturer to coordinate with the motor manufacturer to ensure that the motor is suitable for the application, or to provide a motor protecting DV/DT filter on the drive output to protect the motor. The manufacturer shall adjust the carrier frequency to minimize the audible noise of the connected motor.

4. Specify one full set of spare fuses in each drive.

5. An asbuilt drive control schematic (ladder diagram) shall be taped to the inside of the drive cabinet and sent to the Project Engineer and Cornell University’s Project Manager.

H. Submittal and as-built record documentation shall include:

1. Power three-line and complete logic/controls drawings.
2. A list of all factory and field setpoint values.
3. Complete installation, operation, troubleshooting and maintenance manuals.

PART 2: PRODUCTS

2.01 VARIABLE SPEED DRIVES

A. Cornell has three drive application classifications. Each application has a specific set of requirements for controls, displays, and bypasses. These applications are:

1. Non critical Loads (Extended nonscheduled shutdowns are permissible.)
2. Standard Loads (Can be shut down for scheduled maintenance.)
3. Critical Loads (Shutdowns are not acceptable, e.g., Central Heating Plant)

The standard and critical types are custom engineered. The Engineer shall consult Planning, Design and Construction for details prior to proceeding, and on which classification applies.

B. All variable speed drives shall have included in their features the following operational requirements:

1. Auto restart after a power line transient (over or under voltage, or power loss) when the power line returns to normal.
2. Auto restart after selected drive faults. The number of restart attempts shall be adjustable at the drive for zero, one or two.
3. Auto/off/manual switch; manual local speed control; adjustable current limit, adjustable acceleration and deceleration rates; remote start/stop for automatic control. It shall not be necessary to stop the drive when toggling from remote to local speed control.

4. The Engineer shall determine the maximum acceleration and deceleration rates for driven loads. If necessary, drives will be oversized or provided with braking to meet these requirements. Only high inertia fans on steam boilers have required greater acceleration/deceleration capabilities than standard drives can offer.

5. All drives shall be capable of accepting external, normally closed, permissive contacts such as a freeze-stat. The control system shall be designed such that one set of external contacts shall de-energize the motor whether the drive is in automatic, manual drive, or bypass mode. The Engineer should also consider a smoke purge mode for the drive if it is applicable for the building design.

6. All drives shall “on-the-fly” restart into a coasting load. Resynchronization shall not require more than 150% current. Total time following a one second total power loss to reapply full accelerating torque shall be two seconds or less. Process and critical load drives shall be capable of reapplication of torque in less than 1/2 a second, following a one second total power loss.

7. Drives shall have the following extended 100% loss of input power ride-through capabilities:
   a. **Critical Loads**: Two seconds on logic circuits and controls to provide 1/2 a second reapplication of torque. Mechanically latched output contactors may be required.

8. Standard and Critical drives shall have bypasses as follows:
   a. **Standard Loads**
      - The Engineer shall specify either manual (local) or automatic (remote) transfer to bypass.
      - Manual bypass may use either magnetic contactors or non-magnetic transfer switches. Automatic bypass requires magnetic contactors. Drive input and output isolation is required during bypass operation. *The bypass function may be manual or electronic.*
      - Indicating lights are required for all functions.
      - Servicing the drive while on bypass is not required.
      - Bypass overload protection may require Type 30 overloads for high inertia driven loads, such as large fans.
   b. **Critical Loads**:
• Bypasses shall be remotely and locally controlled using a magnetic transfer to bypass and a three wire bypass start/stop scheme.

• Indicating lights shall be provided for all functions.

• Servicing and operational testing of the drive while operating on bypass is required. Provisions to switch control power and drive input power are required.

• Bypass controls and control power shall be totally separate and independent from Drive controls.

• Mechanically latched contactors may be required to meet rolling restart requirements.

• Bypass overload protection may require Type 30 overloads for high inertia driven loads, such as large fans.

All bypasses shall include UL listed short circuit protection and separate UL listed motor overload devices.

9. Enclosures
   a. Unless specified differently, drives and bypass shall have the following enclosures:
      • Non critical Load: NEMA 1
      • Standard Load: NEMA 12, external heat sinks, fan cooled
      • Critical Load: NEMA 12, external heat sinks, fan cooled

   b. Cabinets shall be thermally protected. Cabinets with fans shall have over-temperature alarms and trips. Fans shall be accessible when backed to a wall, without moving the cabinet.

10. Drive Rating
    a. All drives shall be capable of continuous operation at a minimum of 110% of motor nameplate rating, including the service factor.
C. All variable speed drives shall have included in their features the following instrumentation requirements:

1. Output current, frequency, and run time metering.
2. Lights to indicate: OFF, ON, DRIVE RUN, and BYPASS RUN status.
3. Front-of-panel-readable indication of fault type.
4. Auxiliary dry contacts (2 N/0, 2 N/C each, 10A inductive at 120 VAC) to indicate: drive run, bypass run, drive fault, overload.
5. A test card or module for troubleshooting the drive(s) in a building.
6. Isolated 4-20mA speed input follower and speed feedback circuits.
7. A complete as-built wiring diagram shall be permanently affixed to the inside of the drive control section at the end of commissioning with all field setpoints identified.
8. Compatibility to communicate through serial communication with the building DDC equipment, i.e., as Johnson Control N2, if required.

D. The variable speed drives shall have included in their features the following protective requirements:

1. Input disconnect.
2. Ground fault protection.
3. Output overcurrent trip.
4. Motor thermal protection with RTD capability over 100 hp.
5. Stall protection.
6. Drive over temperature.
7. Under voltage trip.

E. Factory service support capabilities:

1. Start-up services shall be performed by a factory trained service engineer.
2. The local service office shall be manned by factory trained service engineers within a 100-mile radius of Ithaca.
3. Training shall be provided for the Owner’s service personnel at the Owner’s facilities.