Controlled
Copy

CCP-CM-007

Revision 2

CCP
Qualitative and Quantitative Drum Counter with Isotopics (IQ3) Scanner

(Equipment #NDA-IQ3-01)

Equipment Description

EFFECTIVE DATE: 01/29/2010

Larry Porter

PRINTED NAME

APPROVED FOR USE

RECORD OF REVISION

Revision Number	Date Approved	Description of Revision
0	04/11/2007	Initial issue.
1	02/28/2008	Updated to address management assessment issues regarding fire extinguishers in the Isotopic System Gamma (IQ3) Scanner facility as a result of Central Characterization Project (CCP) Corrective Action Report (CAR) CAR-CCP-0008-07.
2	01/29/2010	Updated for Equipment Change Authorizations (ECAs) CM09-0014, CM09-0015, CM09-0016, CM09-0018, CM09-0019, and CM09-0020 as applicable when equipment was moved from Savannah River Site (SRS) to Oak Ridge National Laboratory (ORNL). Also updated to include additional information/requirements on Liquid Nitrogen (LN) System, editorial changes for clarity, and to eliminate redundancy.

TABLE OF CONTENTS

1.0 SYSTEM DESCRIPTION 8
1.1 Facility Major Components, and Subsystems 8
1.1.1 Facility 8
1.1.2 Major Components 9
1.1.2.1 IQ3 Scanning System 9
1.1.2.2 Transmission Sources/Sealed Sources 10
1.1.2.3 External Conveyors 10
1.1.2.4 Internal Conveyor and Related Components 11
1.1.2.5 Other Components 12
1.1.3 Subsystems 12
1.1.3.1 Civil and Structural (Trailer) 12
1.1.3.1.1 Control Room 13
1.1.3.1.2 Equipment Bay 13
1.1.3.2 Mechanical and Material 14
1.1.3.3 Chemical and Process 14
1.1.3.4 Electrical Power 15

2.0 DESIGN REQUIREMENTS 17
2.1 Specific Requirements 17
2.2 Codes and Standards 17

3.0 OPERATIONAL INFORMATION 18
3.1 System Control Features 18
3.1.1 Instrumentation and Control 18
3.1.1.1 Audio/Video and Monitoring System 18
3.1.1.2 Telephone Communication 18
3.1.1.3 Warning Lights 18
3.1.2 Fire Protection 18
3.1.2.1 Fire Protection Equipment 18
3.1.2.2 Alarm Systems 19
3.1.3 Emergency Shutdown Devices 20
3.1.4 Other Fire Codes and Regulations 20
3.1.5 Radiation and Other Hazards 20
3.1.5.1 Transuranic Waste Drum Dose Rate Limits 20
3.1.5.2 As Low As Reasonably Achievable (ALARA) 21
3.1.5.3 Nuclear Criticality Safety 22
3.1.6 Cryogenic and Compressed Gas Hazards 23
3.1.7 Industrial Hazards 24
3.1.8 Operating Environment and Natural Phenomena 24
3.1.8.1 Natural Phenomena Hazard Fire Impacts 25
3.1.9 Human Interface 25
3.1.9.1 Manual Operator Interface 25
3.1.10 Maintenance/Other Requirements 26

4.0 REFERENCES 27

LIST OF ATTACHMENTS

Attachment 1 – Equipment Setup Requirements 30
Attachment 2 – Drawings 32

LIST OF FIGURES

Figure 1. Manual Operator Interface Hardware 25

LIST OF TABLES

Table A. Installation Specifications 30
Table B. Recommended Minimum Required Area 31

LIST OF APPENDICES

Appendix 1 – Placement and Leveling 28

LIST OF ACRONYMS AND ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Am	Americium
ANSI	American National Standards Institute
Ba	Barium
CFR	Code of Federal Regulations
cm	centimeter
CPU	Central Processing Unit
Cs	Cesium
DOE	U.S. Department of Energy
dpm	disintegrations per minute
EPA	U.S. Environmental Protection Agency
FRAM	Fixed-energy Response Function Analysis with Multiple efficiencies
HC	Hazard Category
HVAC	Heating, Ventilation, and Air Conditioning
IQ3	Qualitative and Quantitative Drum Counter with Isotopics
LEGe	Low-Energy Germanium
LN	Liquid Nitrogen
LO	Lead Operator
mCi	millicuries
MCU	Mobile Characterization Unit
MDA	Minimum Detectable Activity
MGA	Multi-Group Analysis
mm	millimeters
mrem	millirem
nCi/g	nanocuries per gram
NDA	Nondestructive Assay
NFPA	National Fire Protection Association
Np	Neptunium
PLC	Programmable Logic Controller
psi	Pounds per Square Inch
Pu	Plutonium
RCT	Radiological Control Technician
RMA	Radioactive Materials Area
rpm	revolutions per minute
RWP	Radiological Work Permit

LIST OF ACRONYMS AND ABBREVIATIONS (Continued)

SEGe	coaxial germanium
Sr	Strontium
STD	standard
TMU	Total Measurement Uncertainty
TRU	Transuranic
U	Uranium
UPS	Uninterruptible Power System
VAC	Volt Alternating Current
WAC	Waste Acceptance Criteria
WIPP	Waste Isolation Pilot Plant
WSMS	Washington Safety Management Solutions

SUMMARY

The Qualitative and Quantitative Drum Counter with Isotopics, (IQ3) Scanner (Equipment #NDA-IQ3-01), is a gamma spectroscopy based nondestructive assay (NDA) system that quantifies the activity of individual radioisotopes and/or determines the isotopic ratios for actinides such as plutonium (Pu) and uranium (U).

The IQ3 system includes the assay system, supporting components and a transportation trailer. It requires only electrical power and liquid nitrogen to operate. The IQ3 provides assay functionality that meets the requirements of the Waste Isolation Pilot Plant (WIPP) Waste Acceptance Criteria (WAC) (U.S. Department of Energy [DOE]/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*) (Reference 1) and DOE/NV-325, *Nevada Test Site Waste Acceptance Criteria* (Reference 15).

This Equipment Description is a central coordinating link among the engineering design documents, the facility authorization basis, and implementing procedures. This Equipment Description does not originate requirements or basis information, but rather collects that information into a convenient usable form. The Equipment Description consolidates information about the IQ3 scanner into one document.

1.0 SYSTEM DESCRIPTION

The NDA IQ3 system can directly assay Pu-239, Pu-241, Americium (Am)-241, U-233, U-235, U-238, and Cesium (Cs)-137, as well as many other gamma emitting nuclides that may be present in waste. In addition, IQ3 can measure the relative isotopic abundance of the plutonium isotopes Pu-238, Pu-239, Pu-240, and Pu-241 using either the Multi-Group Analysis (MGA) code, or the Fixed-energy Response Function Analysis with Multiple Efficiency (FRAM) code. Other actinides that are measured include U-235, Am-241, Neptunium (Np)-237, and Am-243.

Pu-242 is estimated by a correlation algorithm under both codes. A code similar to MGA is used to calculate the isotopic ratios for the uranium isotopes U-234, U-235 and U-238. The isotopic ratios are then tied to the Pu-239 or U-235 mass values to provide direct assay values for all of the nuclides. The other nuclides, such as Strontium (Sr)-90, can be inferred by ratioing to easily measured nuclides, such as Cs-137. These ratios are based on acceptable knowledge compiled for each waste stream. The standard assay output of the system quantifies the total fissile gram equivalent of the drum and automatically calculates the Minimum Detectable Activity (MDA). Depending on the type of waste being assayed, the system has the detection level capability to assay down to the 10 nanocuries (or less) per gram (nCi/g).

A demonstration with the IQ3 at the Savannah River Site in 1996 demonstrated MDAs of 10 nCi/g for Pu-238 and Pu-239. A similar system is routinely used for low-level counting of the Am-241 nuclide to detection levels on the order of 1nCi/g. Detection levels of 10 nCi/g are based on a 30-minute assay time. A Total Measurement Uncertainty (TMU) analysis, which has been audited and approved by the DOE/Carlsbad Field Office and the U.S. Environmental Protection Agency (EPA), is performed on all assay results with TMUs at the 95% confidence level.

1.1 Facility Major Components, and Subsystems

1.1.1 Facility

Structures, Systems, and Components for the IQ3 should be, at a minimum, classified as Balance-of-Plant to assure that proper design, operations, and maintenance requirements are assigned to provide for the health and safety of the worker and the environment and to ensure compliance with the other Host site requirements.

The IQ3 system function, classified according to Section 3.0 of DOE Standard (STD) 3024-98, *Content of System Design Descriptions* (Reference 2), is “Mission Critical”. This classification is based on the need for continued IQ3 operation to meet DOE programmatic mission objectives.

The IQ3 is optimized to assay 55-gallon drums containing low level and Transuranic (TRU) waste quickly and accurately. It has a conveyor and loading system for

automatically or manually moving 55-gallon drums into the shielded assay chamber and placing them on a turntable.

The IQ3 system is contained in a semi-trailer. The trailer has a double axle and a fifth wheel for transportation with a diesel tractor-trailer. See Attachment 2, Drawings, for the system layout.

1.1.2 Major Components

The IQ3 system is composed of four major components:

- IQ3 Scanning System
- Transmission Sources/Sealed Sources
- Conveyors (Internal and External)

1.1.2.1 IQ3 Scanning System

The IQ3 Scanning System consists of a counting chamber with three uncollimated coaxial germanium (SEGe) detectors that view the drum directly across from three transmission sources for determining matrix density. Measurements of individual radioisotope activities are made with and without transmission sources being exposed to the drum. SEGe detectors perform quantitative gamma assay measurements.

Three Low-Energy Germanium (LEGe) detectors are positioned at right angles to the transmission source-coaxial detector axis to determine isotopic ratios of plutonium and uranium in the waste container. Assays meet the requirements of the WIPP WAC (Reference 1).

The counting chamber is a 15-centimeter (cm) (6-inch) thick low background steel shield to minimize the impact of background radiation and improve the MDA of the system. The basic shield shell requires no maintenance. The interior of the shield is protected with a polyvinyl chloride liner. The liner can be washed for decontamination purposes, and can be replaced if required. The IQ3 has an automated shield door opening and door-mounted loading system for moving 55-gallon drums into the shielded assay chamber and placing them on a turntable. Both systems are actuated by a synchronous motor drive, yielding 43 inches of horizontal door travel at approximately 2 inches per second and 13.5 inches of vertical travel for the lifting device at approximately 0.83 inches per second. Mechanical limiting switches are provided on both systems that provide signals to the Programmable Logic Controller (PLC) used in the motor control. An emergency stop condition (hard-wired) is initiated upon malfunction of the door or lifting device. An internal brake, with a brake fail-stop operation and manual brake release, is also provided on each system for positive stopping.

The turntable is actuated by a permanent Direct Current gear-motor with a rotation speed of the turntable during a measurement set at 4 revolutions per minute (rpm). The rotation speed ramps down to 1.5 rpm when rotating to the home position. Inductance proximity switches that sense a steel indictor bracket, providing input signals for the PLC, determine rotational position. A torque protection/clutch system is mounted on the motor shaft and activates in case of an obstructed turntable or when stopping a rapidly rotating heavy load.

1.1.2.2 Transmission Sources/Sealed Sources

The IQ3 has three radioactive transmission sources (Barium-133 [Ba-133]) installed in a lead and steel shield (no lead is exposed). These are nominally 10 microCurie (mCi) for Ba-133 standards. A tungsten shutter attenuates gamma rays emitted from the source when the shutter is closed. The shutter is opened by an electrical solenoid and closes by gravity, thus, the shutter is fail-safe if power is lost. The shutter is interlocked with the door thus, the sources cannot be exposed when the door is open. For safety, access to the equipment bay is controlled by the operator during normal operation and when performing maintenance and repairs.

1.1.2.3 External Conveyors

External loading and unloading conveyors can be set up as needed at the host site. Height is adjustable and standard conveyor sections are used to make the length as needed. Conveyors may be as shown on Attachment 2, Drawing 95205 Sheets 2 and 13. An equivalent arrangement may also be used to accommodate site conditions. Typical IQ3 conveyor components and dimensions are:

- Sections in Lengths of 117-inches (2,972 millimeters [mm]) or fit to available space at the host site location
- Height from the ground to top of rollers) adjusts from 53 inches (1,346 mm) to 77 inches (1,956 mm)
- Effective conveying width is 30-3/4 inches (781 mm)
- Rollers are 2-9/16 inches (65 mm) in diameter, made of 7gauge (5 mm) material
- Roller centerlines are 4-1/2 inches (114.3 mm) apart
- Axles are made of 11/16-inch (17.5 mm) hex bar and are retained with springs
- Rollers are live, driven by a ¾-horsepower motor through a 60:1 gearbox for a conveying speed of approximately 20 feet per minute (6.1 meters per minute).

Conveyor height is based on the nominal 41 inch (1,041.4 mm) ground to trailer deck height plus the 24 ¾ inches (628 mm) trailer deck to rotator height. Conveyor support

leg feet are designed to allow independent adjustment for leveling on uneven surfaces. Height and length may be adjusted beyond the typical dimensions shown and components may vary as needed for conditions at the host site. Side rails, end stops and covers are added as needed or when required by the host site.

1.1.2.4 Internal Conveyor and Related Components

The internal (sample loading) conveyor is located inside the trailer on both sides of the IQ3 scanner unit. The in-feed side transports drums from the external in-feed conveyor to the assay/scanning system, between the vault and the open vault door. The conveyor also transports drums from the scanning system vault out to the external out-feed conveyor.

Like the in-feed and out-feed conveyor sections, the internal (sample loading) conveyor can handle 55-gallon drums and is load tested for 1,000 pounds (454 kilograms). This conveyor is mounted on a single ended shear beam load cell assembly. The shear beam operates a drum weighing system with a load cell on each end of the shear beam (four total). The load cells are connected to high-resolution input modules on the PLC. Weighing results are sent to the computer through the RS-422 serial communication. The middle conveyor is driven by a synchronous brake motor that drives a 45:1 gear box, yielding a drum travel of approximately 20 feet per minute.

When a drum moves from the external in-feed conveyor to the internal conveyor to be assayed, all operations, including sample loading, unloading, and drum weighing (if required), are under computer control, minimizing the need for operator interaction with the system.

A sensor located at the beginning of the internal in-feed conveyor provides a signal to automatically feed the drum to the location of the open vault shield door. When the drum arrives at the vault door, the drum is sensed with photoelectric sensors located along the conveyor sides. Photoelectric sensors provide a signal for two drum centering pins that are raised by solenoid under the pins to provide the proper lateral positioning (this positioning is at a right angle to the travel direction of the internal conveyor). The two centering pins are located in the channel between rollers. The centering pins, when raised, are approximately 1/2-inch above the rollers and guide a moving 55-gallon drum to its proper lateral position on the conveyor. See Attachment 2, Canberra Drawing 95205 Sheet 18, for details. When the centering pins position the drum on the internal conveyor, it is aligned with the centerline of the drum turntable.

When the drum is in this position, photoelectric sensors provide a signal for a lifting mechanism to raise the drum. The lifting mechanism is configured like forklift tines and it is attached to the vault door (which is opened to the far side of the internal conveyor at this time). Prior to lifting the drum, the lifting mechanism tines fit between conveyor rollers. When the drum is properly positioned, the lift mechanism is given the signal to lift the drum. When the drum is raised to the proper height, rotary limit switches provide

a signal to close the vault door. Sensor tape strips on the door prevent the door from closing if the drum is not properly positioned as discussed in Section 1.1.3.4.

The vault door then moves toward the vault (with the lifting mechanism carrying the drum). When other rotary switches sense that the vault door is closed, they provide a signal to lower the drum onto the scanner turntable. The drum is then lowered. When the detectors indicate the drum is resting on the turntable, the turntable begins to rotate. Shortly after this, acquisition begins and the Sample Information page will be displayed.

When the assay is complete, the drum is automatically lifted, removed from the vault, placed on the internal conveyor and transferred to the out-feed conveyor. An operator interface control that loads drums onto the in-feed (load) conveyor and unloads drums off of the out-feed (unload) conveyor is at the end of each respective conveyor. The operator interface comes complete with 15 feet of cable so that the user may position it as preferred.

1.1.2.5 Other Components

- Heating, Ventilation, and Air Conditioning (HVAC) System
- Emergency Shutdown Devices
- Warning Lights
- Electrical and Lighting
- Communications
- Computer

1.1.3 Subsystems

The IQ3 is a self-contained, stand-alone unit that requires only electrical power and liquid nitrogen to operate.

1.1.3.1 Civil and Structural (Trailer)

The trailer is 54 feet long, 15- ½ feet high, and 8 feet wide. It weighs approximately 60,000 pounds (27,216 kilograms) (excluding conveyors). The structure can be transported over highways without any special provisions. The trailer was manufactured by Wabash National in 1990. It is a model SA-102 with a 14 inch drop at the goose neck, the S/N is 1JJV482V9LL146778.

The trailer unit is divided into two sections that consist of a Control Room, located at one end of the trailer, and an Equipment Bay that houses the IQ3 scanner. Automated conveyor systems connect with the IQ3 scanner for loading and unloading drums.

Access to the exterior loading conveyors and drum-loading area is located at the side doors of the IQ3 system trailer. Forklift access areas will be provided as required by the host site (typically a minimum of 20 feet from the loading side of the exterior conveyor). One set of stairs is provided for personnel access to the control room located on the curbside of the trailer. Another stair may optionally be provided at the rear curbside door for personnel access to the equipment area. A layout of the IQ3 system is shown in Attachment 2. Each of the drawings referenced below can be found in the *IQ3 Hardware Reference Manual*, WIPP ACK #D6247 (Reference 3):

1.1.3.1.1 Control Room

- Walls: 3/8-inch plywood with vinyl PYRO PanL-fire retardant wall cover connected directly to the plywood, 3/8-inch plywood is connected directly to 2-inch by 4-inch wood studs (the 2-inch by 4-inch studs are connected to the exterior metal walls of the trailer) (Attacment 2 Drawing 95015, Sheet 7, Rev. D).
- Ceiling: Drop ceiling panels, plastic lighting panels (Attachment 2 Drawing 95015, Sheet 3, Rev. H)
- Floor: Plastic/Vinyl tile over hardwood sub-floor connected directly to the frame of the trailer
- Control Console: Computer, printer, office chairs, and one working desk (Drawing 95015, Sheet 1, Rev. H, Item 4)
- Main Breaker Panel (Attachment 2 Drawing 95015, Sheet 8, Rev. D)
- A 1-ton HVAC Unit (wall mounted) (Attachment 2 Drawing 95015, Sheet 3, Rev. H)
- Uninterruptible Power System (UPS) located near the computer (an older UPS is abandoned in place by the computer for use as a backup).

1.1.3.1.2 Equipment Bay

- Walls: Same as the Control Room walls (see above)
- Ceiling: Vinyl PYRO PanL-fire retardant (same as the Control Room “Walls” description)
- Interior wall: 2-inch by 4-inch steel studs. 3/8-inch plywood (both sides of wall) secured to steel studs, 2-inch thick solid foam insulation between the studs. Vinyl PYRO PanL-fire retardant fastened with nylon drive rivets, seams and corners fitted with 1/8-inch heavy duty structoglas accessories (Attachment 2 Drawing 95015, Sheet 7, Rev. D)
- Floor: Hardwood floor

- Utility Unit Heaters: Two heaters are mounted and/or bracketed to the wall in the equipment bay above the IQ3, to provide climate control for personnel inside the area, these heaters are not provided to support the operation of the IQ3 (Attachment 2 Reference Drawing 95015, Sheet 8, Rev. D)

- The IQ3 Gamma Scanner unit

- Liquid Nitrogen panel and Dewars (Dewars may be stored on a rack outside IQ3).

1.1.3.2 Mechanical and Material

The HVAC system provides comfort control in the office area. The equipment is wall-mounted on the exterior end of the trailer. The equipment bay has no HVAC.

- BARD Air Conditioner
- 208-Volt Alternating Current (VAC) 3 Phase
- 35-Amp Breaker
- W/SUB-Base #8404-010

Mechanical Systems

- Shield and Counting Chamber
- Door-Mounted Forklift
- Shield Door
- Nuclear Instrument Module Electronics
- Programmable Controller
- Host personal computer
- Genie-personal computer for acquisition and display
- Gamma waste assay software
- Turntable
- Detector array

1.1.3.3 Chemical and Process

The IQ-3 detection system includes an automatic Liquid Nitrogen (LN) fill system. It is used regularly (every three to four days) to refill Dewars because the SEGe Germanium detectors and the LEGe detectors require liquid nitrogen for cooling. The LN Control Panel is located inside the IQ-3 Equipment Bay. It has a FILL switch that activates the blue light on the light stack in the control room when it is in the “FILL” position. Blue lights on the Control Panel indicate which Dewar is currently being filled

See Section 3.1.6 for hazards and precautions that must be taken before using or servicing the LN system or components.

Liquid nitrogen cylinders are stored close to the IQ3 unit. They are located as determined by site needs. The cylinders are secured to the conveyor or trailer unit. There are six 7.5-liter Dewars that are involved in filling the germanium detectors with liquid nitrogen. They are filled with LN from an external cylinder. Detectors are filled on a regular cycle (about every four days). The detectors take approximately 60 minutes to fill. The filling process is monitored on the detector fill display board. A blue light on the display board indicates which detector is currently being filled.

The SEGe detectors and the LEGe detectors require liquid nitrogen cooling for proper operation. Routine filling of the detector Dewar ensures continuous operation of the detector. The extremely cold temperature of liquid nitrogen can cause severe burns to the skin. When filling the detector Dewars, protective cryogenic gloves and a face shield should be worn in addition to standard safety glasses to prevent contact with human tissue. These items are kept in the equipment bay area.

NOTE

Personnel responsible for filling the detectors with liquid nitrogen must wear eye protection and cryogenic gloves to prevent skin and eye contact. The fill must be performed with trailer doors open to prevent an asphyxiation hazard as the LN vaporizes to a gas. The LN bottles are stored outside of the trailer.

1.1.3.4 Electrical Power

The system requires 208-VAC, 3 phase with neutral and ground. The unit has an UPS (Emerson Liebert GTX2-300RT120 model). If auxiliary power is required from diesel generators, the generators and diesel fuel tanks are installed and separated from important structures in accordance with the requirements of National Fire Protection Association (NFPA) 30, *Flammable and Combustible Liquids Code* (Reference 5), which requires a minimum separation distance of 25 feet.

EXTERNAL POWER CONNECTIONS

The access to the electrical power feed panel is on the underside of the IQ3 trailer. External power is hard-wired from the site to the main breaker panel. The trailer is typically grounded to the host site grounding grid by a cable from the rear of the trailer.

Two utility unit heaters are located above the chamber (one on each side of the chamber). These heaters are used for climate control for personnel and are not required for equipment operation.

Because most sites elect to make a direct tie-in to the Host site electrical power supply, a plug is not provided. The tie-in point on the trailer is located approximately ten feet from front end of the trailer unit under the trailer and directly below the electrical panel. An electrical drop is provided.

SAFETY INTERLOCKS

Safety interlock devices include:

- Emergency stop push buttons (discussed in Section 3.1.3)
- Tape strip switches (discussed in Section 1.1.2.4) are located on the shield door as follows:
    - On the bottom outside edge to prevent the door from opening when there is a drum on the conveyor adjacent to the door
    - In-feed inside edge to prevent closing the door on a drum
    - Out-feed inside edge to prevent closing the door in a drum.
- Rotary limit switches (discussed in Section 1.1.2.4) are located as follows to prevent shield door over travel:
    - Two on the upper door frame to prevent raising the door too high when opening it
    - One on the lower edge of the door frame to stop lowering when the door is closed.
- Rotary limit switches prevent damage to drums by limiting travel of the forklift on the shield door:
    - Chamber opening height is sensed by switch S8
    - Conveyor height is sensed by switch SF7

All the safety devices are wired in a fail-safe circuit, which will disconnect power from the equipment actuators. The PLC remains powered in an emergency stop condition to maintain communication and status information.

Resetting the control power is initiated with a reset/override switch at the manual control panel that is located on the chamber door frame. Holding the reset/override switch can override an interlock circuit (such as a fork overtravel switch) but cannot override any of the emergency stop switches.

A manually operated main disconnect switch, located on the door of the electrical cabinet (JB10), removes all power from the shield and cabinet. There is also a switch on the PLC cabinet that removes power from all components, including the PLCs. The cabinets with these disconnects are located at the rear of the equipment bay.

Controlled
Copy

2.0 DESIGN REQUIREMENTS

2.1 Specific Requirements

While quantitative design requirements have not been identified for the IQ3, the system must be capable of assuring that fissionable material in its inspected drums does not exceed that permitted by the WIPP WAC (Reference 1). The facility at which the IQ3 operates must also establish that the system, in its site-specific implementation, meets Title 10, Code of Federal Regulations (CFR) Part 830, *Nuclear Safety Management*, Subpart B, Safety Basis Requirements (Reference 6), and 10 CFR 835, *Occupational Radiation Protection* (Reference 7), and other requirements applicable to that site.

2.2 Codes and Standards

While codes and standards have not been identified as design requirements, a number of codes and standards have been used in the “as-built” system and are identified, where applicable.

3.0 OPERATIONAL INFORMATION

3.1 System Control Features

3.1.1 Instrumentation and Control

3.1.1.1 Audio/Video and Monitoring System

A video camera is mounted in the Equipment Bay on the interior wall of the unload side of the trailer. This video camera allows the operator to view the inside of the chamber during loading and unloading operations until the chamber closes. The operator views this operation from the control panel monitor. This process is limited to a one-drum process by design. The throughput is approximately 30 minutes per drum. Approximately 16 to 20 drums a day can be processed through the IQ3 at this rate.

Once the assay is completed, the IQ3 automatically unloads the drum to the unload conveyor. The drum is then removed from the unload conveyor using a forklift.

3.1.1.2 Telephone Communication

The Mobile Characterization Unit (MCU) operations require one normal phone line and one Internet line. The phone box is located on the exterior front end of the trailer.

3.1.1.3 Warning Lights

The operator monitors the control tower lights for the load/unload process and acquisition. The lights are located in the control room.

- The AMBER light is illuminated when there is any motion in the system
- The WHITE light is illuminated during the acquisition of the data
- The RED light is illuminated when the transmission source shutter is open
- The BLUE light is illuminated when a liquid nitrogen fill cycle is in progress

3.1.2 Fire Protection

3.1.2.1 Fire Protection Equipment

DOE Order 420.1.B, *Facility Safety* (Reference 8), Section 4.2.2.3, requires a full automatic suppression system in significant facilities; facilities subject to the loss of safety class systems, significant life safety hazards, and unacceptable program interruptions and in facilities where the fire loss could exceed acceptable limits. The designation of significant facilities and the determination of acceptable loss limits is the responsibility of the Host site.

The IQ3 unit does not meet any of the DOE Order 420.1.B (Reference 8) criteria for which an automatic suppression system is required. DOE Order 420.1.B (Reference 8), Attachment 2, Section 4.2.2.3, requires a full automatic suppression system in significant facilities and in facilities where a fire loss could exceed acceptable limits.

This analysis assumes that the IQ3 unit is not considered a significant facility, is not a safety class system, and the maximum loss is assumed to be less than the acceptable limits for the host facility. However, the designation of significant facilities and the determination of acceptable loss limits is the responsibility of the Host site.

The IQ3 unit is provided with an independent HVAC system for climate control of the control room. The design of this system meets the requirements of NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems* (Reference 9), Section 4-4.2. There is no ductwork associated with this system; therefore, smoke detectors are not required in the HVAC system. Smoke detectors are not required in the HVAC ductwork when the HVAC unit supplies less than 2,000 cubic feet per minute. This system has a capacity well under the supply of 2,000 cubic feet per minute.

A ventilation system is required per NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials* (Reference 10), Section 3-9.7.2, to confine radioactive materials released from a fire and remove them from the exhaust ventilation air-stream or release them under controlled conditions to a safe location. NFPA 801 (Reference 10), Section 3-13.1, requires facilities that handle radioactive materials that are potentially dangerous to personnel to have an auxiliary power system for the facility's ventilation system in order to limit the spread of fire. The IQ3 unit HVAC system is not used to separate a radioactive area from a non-radioactive area, and therefore, is not required to meet these code requirements. The IQ3 unit is not provided with a confinement ventilation system that prevents a release of radiological material to the environment in accordance with the NFPA 801(Reference 10), Section 3-9.7.2. However, the HVAC system would not be considered deficient if the unit were sited to address these concerns.

3.1.2.2 Alarm Systems

Smoke-alarms may be positioned in the Control Room and the Equipment Room as required by the host site to alert workers. If installed, the smoke alarms can be wired into the Host site building alarm systems as required by the Host site fire protections program requirements. This is not normally necessary for safe operations of the IQ3. Smoke alarms may be both audible and visible to workers.

Fire protection system components will comply with site requirements and NFPA 101, *Life Safety Code* (Reference 11), Section 40.3.4.1, based on the occupancy type and the projected number of occupants (normally only two or three persons but no more than five persons within the control room operating area at a time).

FIRE EXTINGUISHERS

A hand-held ABC fire extinguisher is located in the IQ3 trailer office/control room. It is the primary fire protection device.

3.1.3 Emergency Shutdown Devices

There are five emergency stops located as follows:

- Two in the Equipment Bay area
- Two located on the conveyors
- One in the Control Room

For additional details on Emergency Shutdown devices for the IQ3, see CCP-TP-047, *CCP Mobile IQ3 Gamma Scanner Operation* (Reference 4).

3.1.4 Other Fire Codes and Regulations

The IQ3 structure is classified as a Type II (000) structure in accordance with NFPA 220, *Standard on Types of Building* Construction (Reference 12). NFPA 801, Section 3-5 (Reference 10), requires buildings used to handle and store radioactive materials to have either a fire-resistive or noncombustible construction (Type I or Type II in accordance with NFPA 220 [Reference 12]). NFPA 801 (Reference 10), Section 3-8, requires the interior finish of these buildings to be of limited combustible materials.

3.1.5 Radiation and Other Hazards

3.1.5.1 Transuranic Waste Drum Dose Rate Limits

DOSE RATE LIMITS

Drum handling and radiological control requirements are determined by the external radiation dose rate, which should be less than 200 millirem (mrem) per hour. Drum staging areas and the perimeter of the IQ3 trailer are normally posted and controlled as a Radiation Area during operations. The drum can be accepted for examination when the above conditions are met.

Each person performing work at the Host site must sign a Radiological Work Permit (RWP). Normal operations of this type only require the operators of the IQ3 to sign a monthly RWP, but the Host site may determine the frequency of sign-in based on the RWP.

DRUM CONTAMINATION LIMITS

The surface contamination levels on the drum will not exceed the limits for removable contamination specified in 10 CFR 835 Appendix D as specified below:

Alpha Contamination on Drum Surface
Waste drums are not acceptable if removable alpha contamination on the drum surface exceeds 20-disintegrations per minute (dpm)/100 cm^2.

Beta Contamination on Drum Surface
Waste drums are not acceptable if removable Beta contamination on the drum surface exceeds 200-dpm/100 cm^2.

3.1.5.2 As Low As Reasonably Achievable (ALARA)

Radiological posting is used to alert personnel to the presence of radiation and radioactive materials and to aid in minimizing exposures and preventing the spread of contamination. Radiological postings are installed before work begins, and are updated periodically when changes in radiological conditions occur or are expected.

The area of operation around the characterization equipment may be posted as a Controlled Area that bounds a larger area of operations around the equipment. Each access point to a Control Area (as defined in 10 CFR, 835.2 [Reference 7]) shall be posted whenever radiological areas or radioactive material exist in the area. Individuals who enter only the Controlled Areas or radioactive material areas are not expected to receive a total effective dose equivalent of more than 0.1 rem (0.001 sievert) in one year (10 CFR, 835.602 [a], [Reference 7]). However, actual posting and area designations are established by the Host site's RWP.

Radiological areas are posted with signs containing the standard radiation symbol with black or magenta lettering on yellow background (10 CFR, 835.601[b] and 10 CFR, 835.601[c] [Reference 7]). The radiological postings are displayed to signify the actual or potential radiological conditions of the area. Postings are maintained in a legible condition and updated based on the most recent survey results. Signs and labels shall contain the standard radiation warning trefoil colored magenta or black on yellow background. Lettering shall be either magenta or black. Magenta is the preferred color over black (10 CFR, 835.601 [a] [Reference 7]). Unless circumstances do not permit, the standard radiation warning trefoil should be oriented with one blade downward and centered on the vertical axis. Lettering should not be superimposed on the standard radiation warning trefoil (American National Standards Institute [ANSI] 1989). The size of the lettering used on the sign should not detract from the clarity of the standard radiation-warning trefoil.

Physical barriers are used to designate the posted boundaries, when required by the RWP. All work conducted in these areas is controlled by the approved Host site RWPs. All physical barriers shall be placed so that they are clearly visible from all directions

and various elevations. Barriers should not be easily walked over, nor walked under, except at identified access points. Rope, tape, chain, and similar barriers used to designate the boundaries of posted areas should be yellow and magenta in color. No control(s) shall be installed at any radiological area exit that would prevent rapid evacuation of personnel under emergency conditions (10 CFR, 835.501 [e], *Occupational Radiation Protection* [Reference 7]).

Radiological postings are verified daily before entering the IQ3. If the posting is missing, dislodged, or believed to be incorrect, the Lead Operator (LO) and the Radiological Control Technician (RCT) shall be notified. Operators shall not enter until the LO and RCT review the posting and approve entry.

External posting around the equipment is determined and controlled by the Host site RWP and ALARA program requirements. Postings should be maintained in a legible condition and updated based upon the results of the most recent surveys.

- Posting is located near the door in such a way that when the door is opened or closed, the posting remains visible. Signs shall be conspicuously posted, clearly worded, and where appropriate, may include radiological control instructions (10 CFR, 835.601 [d]) (Reference 7).

  ** The Host site establishes Controlled areas normally around the IQ3. The posting serves to warn individuals that they are entering areas that, because of the presence of radiological areas and/or Radioactive Materials Areas (RMAs), are controlled for radiation protection purposes. The RMAs and radiological areas are established within the controlled area to provide warning of specific hazards that may require individual protection action for safe entry and egress.

3.1.5.3 Nuclear Criticality Safety

Per DOE-STD-1027-92, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports* (Reference 13), threshold values for fissile material specified in Table A-1 of Attachment 1 are minimum theoretical masses necessary for a nuclear criticality to occur with moderation and reflection in Hazard Category (HC)-II facilities.

Criticality evaluation of the individual equipment/processes/facilities and an Inventory Control Program are used by the host site according to their AB process due to the HC-II classification.

The minimum theoretical quantity of Pu-239 necessary for criticality assuming favorable configuration, moderation, and reflection is 450 grams (Reference 13). Although a package might contain material favorable for moderation or reflection, inadvertent repackaging into a critical configuration is very improbable due to the low inventory of fissile material and the waste form geometry.

The IQ3 processes one drum at a time; however, there may be additional drums on the conveyors. WIPP WAC criteria and Acceptable Knowledge evaluations preclude any TRU waste drum(s) being processed to the IQ3 for analysis that would challenge criticality safety. DOE facilities where this equipment may operate is normally operated under a Safety Analysis or documented safety basis document, which establishes bounded limits and inventory controls for TRU waste drums.

CAUTION

After the fill cycle is complete, the LN System must be vented as described in the operating procedure (CCP-TP-047) to prevent over-pressurization of the system when the Cryogenic LN vaporizes.

NOTE

Standard LN fittings are used for the IQ-3 LN System and supply cylinders. They are the same size and configuration as fittings used for higher pressure applications (235 and 325 psi). Precautions identified below must be used to assure the LN system will not be over-pressurized, resulting in physical hazards and system damage.

3.1.6 Cryogenic and Compressed Gas Hazards

An automatic LN fill system used to cool IQ-3 detectors is discussed in Section 1.1.3.3. Before using or servicing the LN System or components, verify applicable precautions are used, including:

1. Host Site programs are in place and any applicable procedures are used.

2. Host Site required PPE are used - Personnel responsible for filling the detectors with LN must wear a face shield and eye protection and cryogenic gloves to prevent LN contact with skin and eyes and to protect from extremely cold temperatures.

3. LN filling must be performed with trailer doors open to prevent an asphyxiation hazard as the LN vaporizes.

4. The LN supply shall be from a nominal 22 pounds per square inch (psig) DOT 4L cryogenic liquid cylinder to avoid over pressurizing the detector fill system that is verified to meet the following conditions before it is used with the IQ-3 automatic refill system:

   - Relief valve is rated at 22 psi
   - The pressure gauge does not exceed 30 psig

5. Refill time is about 60 minutes.

6. It is essential that LN be vented from the fill line between the cylinder valve and the atmospheric vent valve at the completion of the fill. Otherwise the LN can over-pressure the system as it heats up and vaporizes.

3.1.7 Industrial Hazards

Hazards identified include the following:

1. Crushing or pinching of extremities and limbs due to forklift or drum handler operations

2. Hand/arm strains or pinches from manual drum handling activities

3. Direct radiation exposure from the TRU contents of the drums

4. Dropping drums, which have the potential to result in a bodily injury or release of radioactive material

5. Exposure to sealed sources

6. Electrical shock

7. Eye strain

8. Chemical exposure – including freezing/burns (see Section 3.1.6)

9. Heat Stress

10. Moving Parts

11. Potential for asphyxiation if the area where LN is used is enclosed

12. Potential for line rupture if LN is not properly vented.

3.1.8 Operating Environment and Natural Phenomena

The characterization units and associated equipment were not designed or built to DOE Natural Phenomena Hazard standards. The associated equipment is not seismically qualified. The IQ3 structure does not perform an emergency function and is not Safety Significant or Safety Class.

Controlled
Copy

3.1.8.1 Natural Phenomena Hazard Fire Impacts

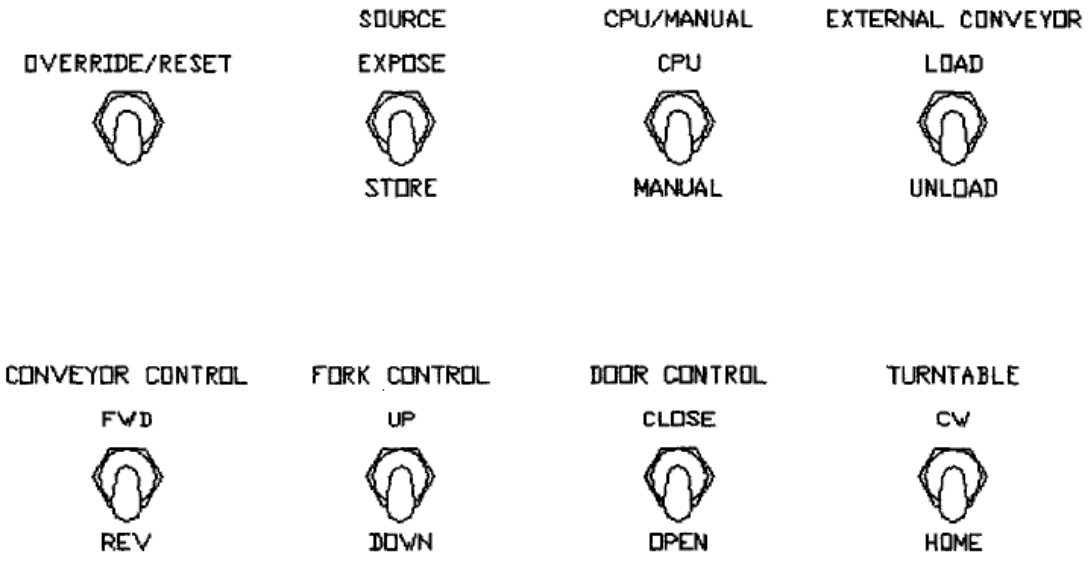
The performance category for the IQ3 Facility is Performance Category 1 based on DOE-STD-1021-93, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components* (Reference 14).

3.1.9 Human Interface

3.1.9.1 Manual Operator Interface

The Manual Operator Interface hardware (see Figure 1, Manual Operator Interface Hardware, below) is located in the Control Junction Box JB10, which is mounted on the IQ3 system.

Figure 1. Manual Operator Interface Hardware



The Central Processing Unit (CPU)/Manual Mode Switch must be positioned in Manual Mode to use the Operator Interface switches. In Manual Mode, commands from the System Computer to the PLC will be ignored by the PLC. In the CPU Mode, the System Computer commands system motion and the Operator Interface only disposes of the Override/Reset switch, which is operational in CPU mode as well as in the Manual Mode.

The Emergency Stop (Push/Pull) on JB 10 aborts every launched action (CPU and Manual Mode). To reset the system in case of an Emergency Stop, pull the Emergency Stop and toggle the Override/Reset Switch S48 or S12.

3.1.10 Maintenance/Other Requirements

Detailed descriptions of the system hardware as well as instrument testing, inspection and suggested preventive maintenance requirements are discussed in the IQ3 Hardware Reference Manual (Reference 3).

4.0 REFERENCES

1. DOE/WIPP-02-3122, *Transuranic Waste Acceptance Criteria for the Waste Isolation Pilot Plant*

2. DOE-STD-3024-98, *Content of System Design Descriptions,* October 1998

3. *IQ3 Hardware Reference Manual*, WIPP ACK #D6247, 2002

4. CCP-TP-047, *CCP Mobile IQ3 Gamma Scanner Operation*

5. NFPA 30, *Flammable and Combustible Liquids Code*, National Fire Protection Association, MA

6. 10 CFR 830, *Nuclear Safety Management*, Subpart B, Safety Basis Requirements, Code of Federal Regulations, U.S. Department of Energy, Washington, DC

7. 10 CFR 835, *Occupational Radiation Protection*, U.S. Department of Energy, Washington, DC

8. DOE Order 420.1.B, *Facility Safety*

9. NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*, National Fire Protection Association, Quincy, MA

10. NFPA 801, *Standard for Fire Protection for Facilities Handling Radioactive Materials*, National Fire Protection Association, Quincy, MA

11. NFPA 101, *Life Safety Code*, National Fire Protection Association, Quincy, MA

12. NFPA 220, *Standard on Types of Building Construction*, National Fire Protection Association, Quincy, MA

13. DOE-STD-1027-92, Change Notice 1, *Hazard Categorization and Accident Analysis Techniques for Compliance with DOE Order 5480.23, Nuclear Safety Analysis Reports*, U.S. Department of Energy, Washington, DC

14. DOE-STD-1021-93, Change Notice 1, *Natural Phenomena Hazards Performance Categorization Guidelines for Structures, Systems, and Components*, U.S. Department of Energy, Washington, DC

15. DOE/NV-325, *Nevada Test Site Waste Acceptance Criteria*

Appendix 1 – Placement and Leveling

PLACEMENT

Due to location of the rear tandem near the back of the trailer, the turning radius for maneuvering the trailer into position will be approximately 40-feet (12.2m) (Reference 14).

The trailer must be parked so that the curbside has adequate clearance for the conveyor and stairs. The trailer should be parked in an area where the following is taken into consideration:

a) The front of the trailer is at a level equal to or higher than the rear of the trailer. If the front pitch is too low, the stairs will not function.

b) Park the trailer so the trailer roadside has adequate clearance for the required amount of conveyors. Table B in Attachment 1 lists the minimum required area but also ensures that there is adequate space for maneuvering the forklift during loading and unloading of the drums from the curbside, and loading and unloading of the drums in the rear of the trailer.

The surface area for placement of the IQ3 scanner should be as level as possible. This structure should be placed on a hardened surface capable of maintaining the load distribution (e.g. concrete, asphalt, or tested compacted soil). Drainage around the structure must be capable to move surface water away from the structure. If the trailer is not level, the platform and stairs will not be level with the surface (Reference 3).

LEVELING

See Canberra Drawing Number 95015, Sheet 1, Revision H, for a schematic.

Once the trailer is properly located, chock the wheels and unhook the trailer. When lowering the landing gear, install a minimum of 12 inch square, 1/2 inch thick steel plate or 4 inch thick hardwood under the footpads.

Level the trailer. The level should be measured on the door rails. For the aft, the level should be spot on. Side-to-side level should have the roadside slightly higher than the curbside (1/2 inch to 1 inch). To level fore and aft, use the landing gear as required.

To level side-to-side, have either a tractor or proper jacking available. Use appropriate-sized shims (steel or hardwood) under the front pads as required.

The Load Stabilizing Jacks are placed under the front and back ends of the trailer using the two-loly column jacks provided (McMaster-CARR # 8812T14 or equal). Place each jack in the front and rear of the trailer under the tubular steel frame.

Appendix 1 – Placement and Leveling (Continued)

Do not attempt to lift trailer with these jacks. Apply enough torque to stabilize the front end when loading and unloading drums.

The Support Pad must be as level as possible. There must be no more than a 1/8-to-1/4-inch deviation in the 10-foot width direction and no more than a 1/2 inch to 1-inch deviation in the 40-foot long direction.

Attachment 1 – Equipment Setup Requirements

Central Characterization Project MCU Installation Specifications

Equipment: Qualitative and Quantitative Drum Counter with Isotopics (IQ3) Scanner (NDA-IQ3-01)

Summary: Table A contains information regarding general site installation and preparation information for the IQ3 MCU.

Table A. Installation Specifications

Weight	Approx. total weight – 60,000 lbs
Primary Electrical Requirements (including overcurrent protection and grounding)	The IQ3 system requires 208 VAC, 3 phase with neutral and ground. The unit has an Uninterruptible Power Supply 500 VA to 3.1-kilovolt amperes (FERRUPS). If auxiliary power is required from diesel generators, the generators and diesel fuel tanks are installed and separated from important structures in accordance with the requirements of NFPA 30 (Reference 5), which requires a minimum separation distance of 25 feet. See also Section 1.1.3.4
Fire Suppression	The IQ3 unit does not meet any of the DOE Order 420.1 (Reference 8) criteria for which an automatic suppression system is required. DOE Order 420.1 (Reference 8), Attachment 2, Section 4.2.2.3, requires a full automatic suppression system in significant facilities and in facilities where a fire loss could exceed acceptable limits Smoke-alarms positioned in the Control Room and the Equipment Room are the primary fire protection systems to alert workers. The smoke alarm can be wired into the Host site building alarm systems, if required by the Host site programmatic requirements, but is not normally necessary for safe operations of the IQ3. A hand-held ABC fire extinguisher is located in the IQ3 trailer office/control room.

Attachment 1 – Equipment Setup Requirements (Continued)

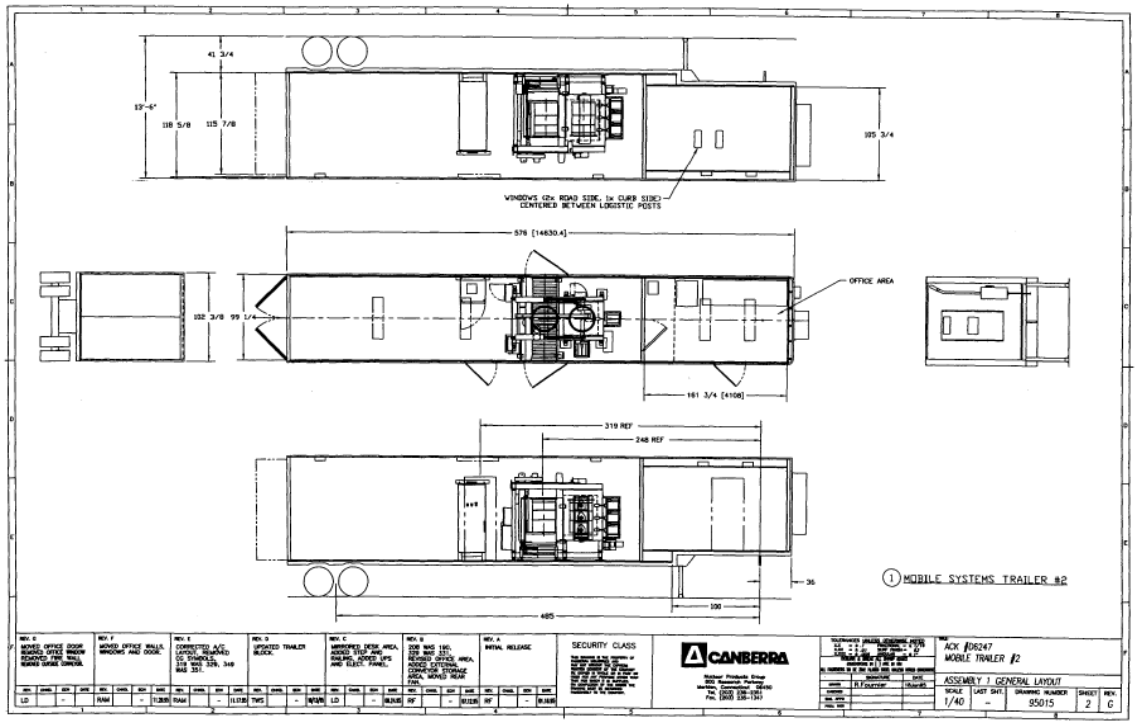
Communication	IQ3 MCU operations require one normal phone line and one Internet line. The phone box is located on the exterior front end of the trailer. See also section 1.1.3.
Footprint	See Table B below
Anchoring Points	See Appendix 1

The following table lists the minimum required area for the IQ3 trailer but also insures that there is adequate area to maneuver forklifts for the loading and unloading of the drums.

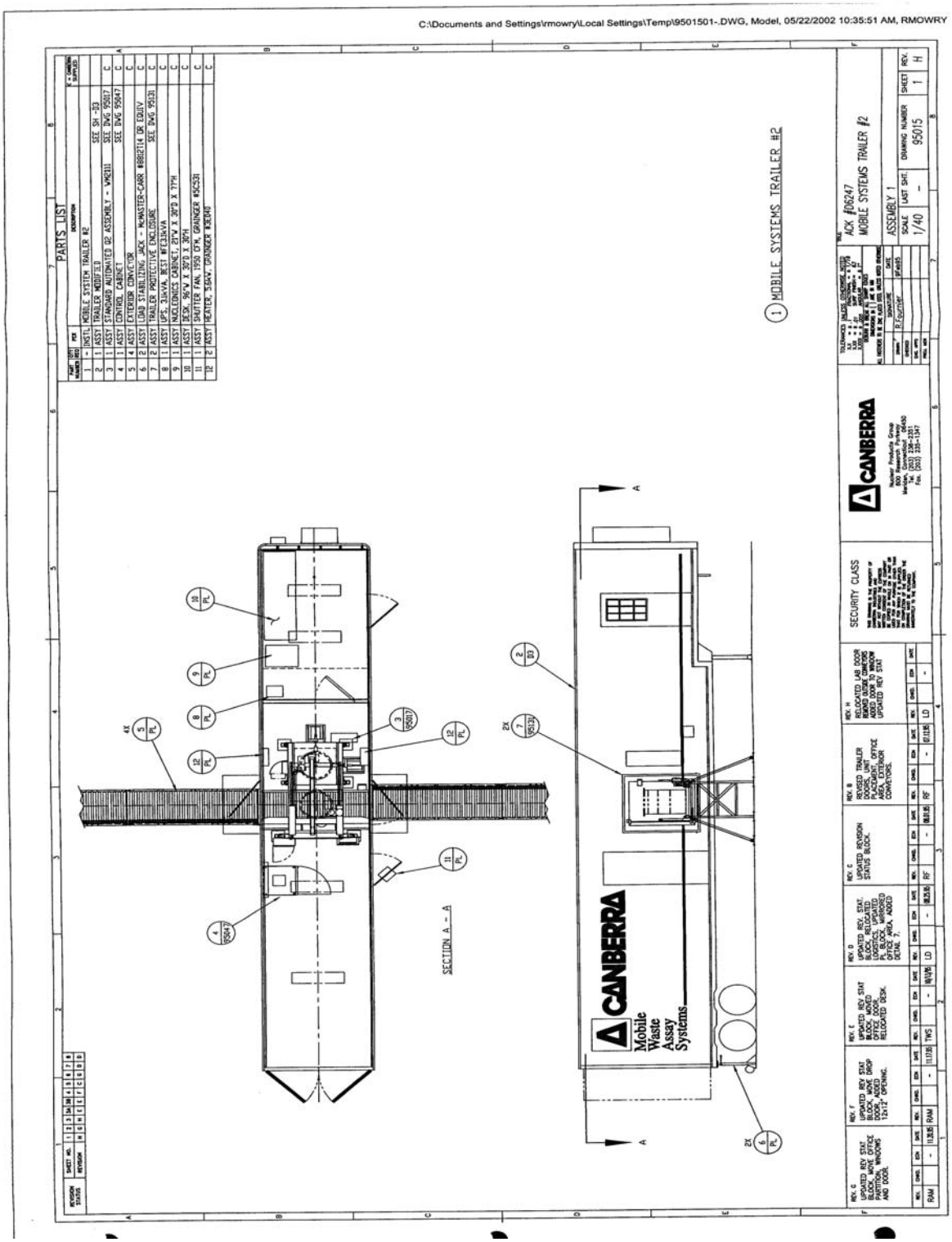
Table B. Recommended Minimum Required Area

Conveyors Used	Road Side (Load Side)	Trailer (Length by Width)	Curb Side (Unload Side)	Total (Length by Width)
20 feet both sides (6.1 m)	20 feet(6.1 m)	54 feet long by 8 feet, 6 inches wide (16.5 m by 2.44 m)	20 feet (6.1 m)	54 feet long by 48 feet, 6 inches wide (16.5 m by 14.6 m)'
10 feet both sides (3.05 m)	10 feet (3.05 m)	54 feet long by 8 feet, 6 inches wide (16.5 m by 2.44 m)	10 feet (3.05 m)	28 feet, 6 inches by 54 feet (8.53 m by 16.5 m)
Forklift	20 feet (from the end of each 20 foot conveyor) (6.1 m)	54 feet long by 8 feet wide (16.5 m by 2.44 m)	Same as road side	88 feet by 54 feet (26.8 by 16.5 m)

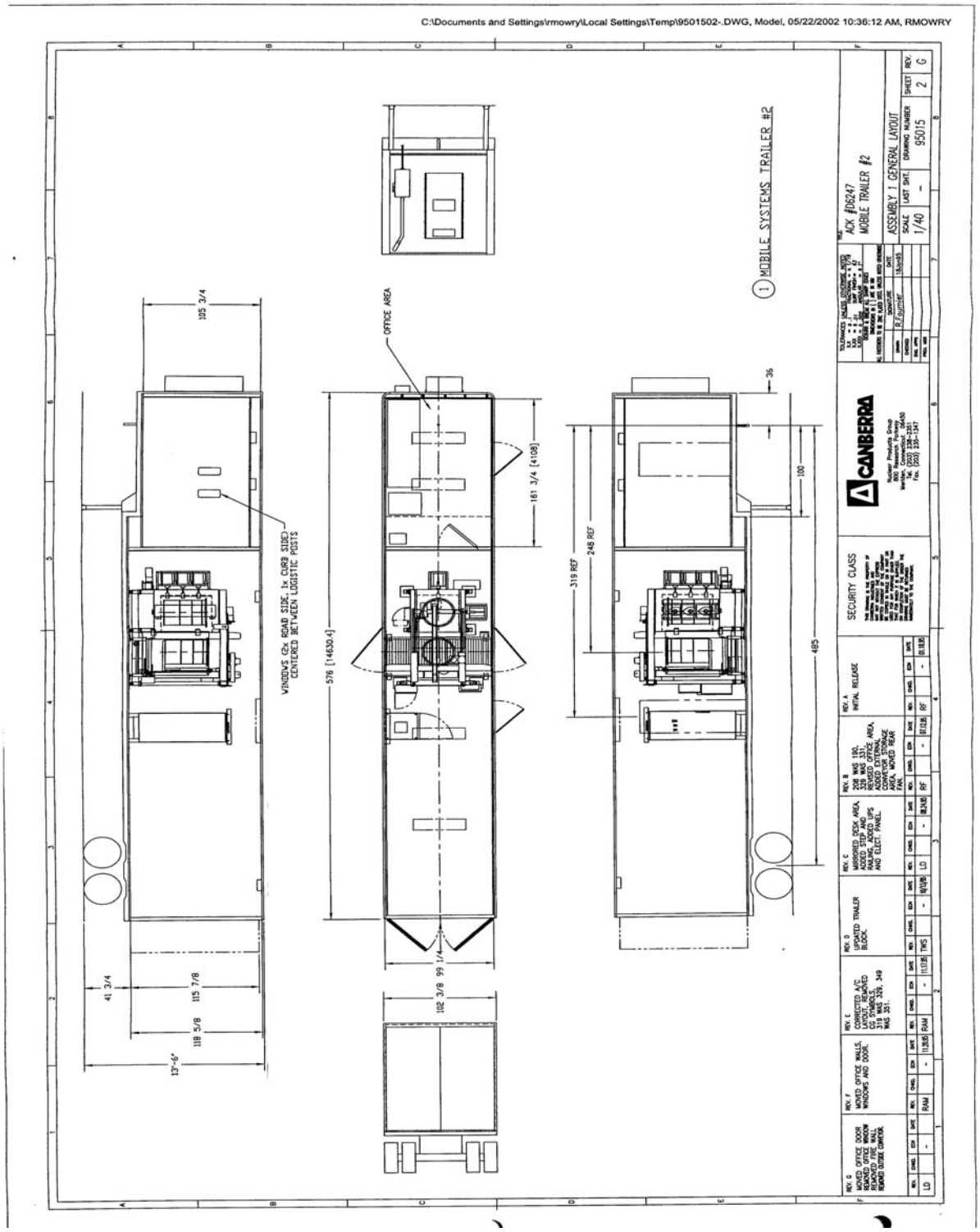
Attachment 2 – Drawings



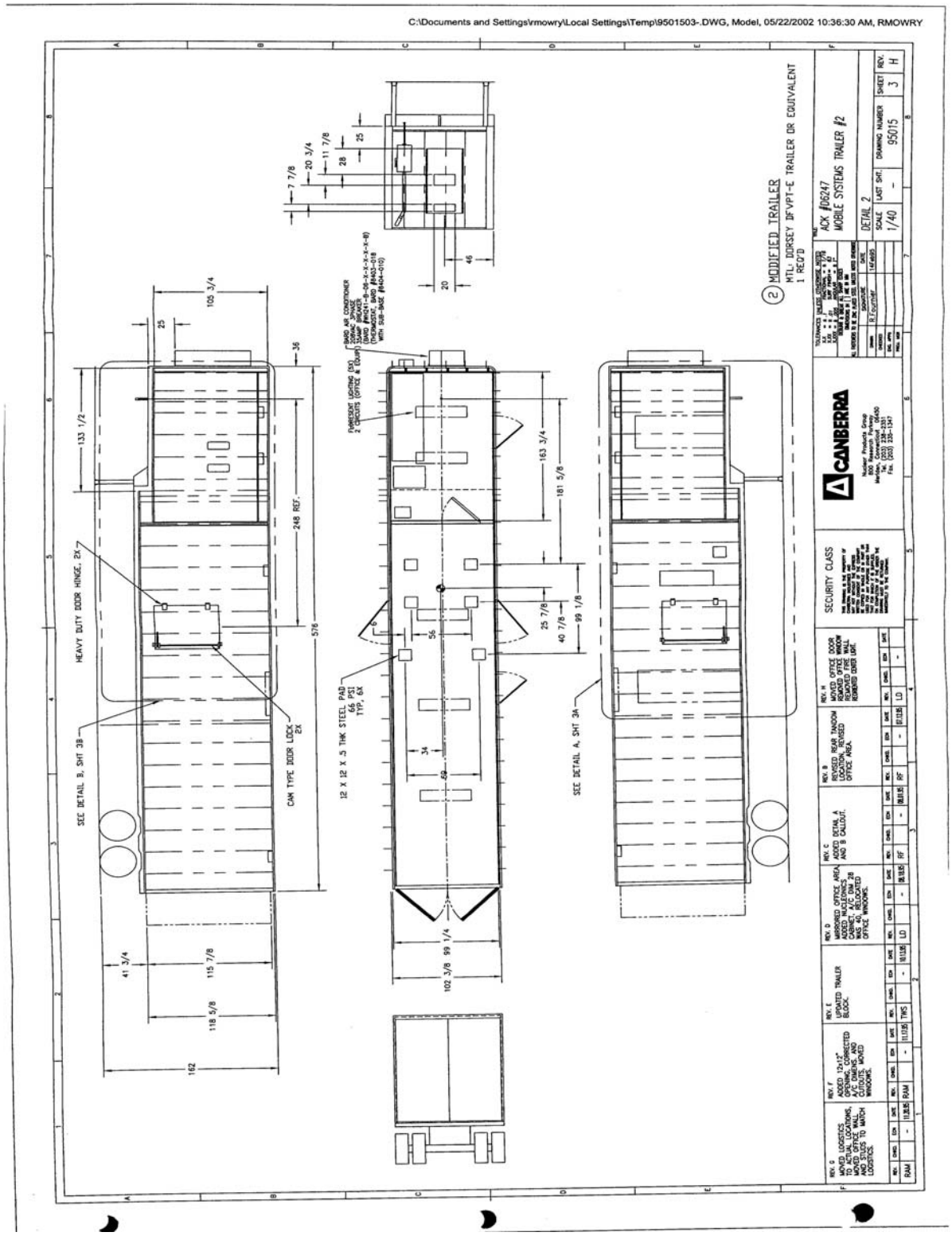
Attachment 2 – Drawings (Continued)



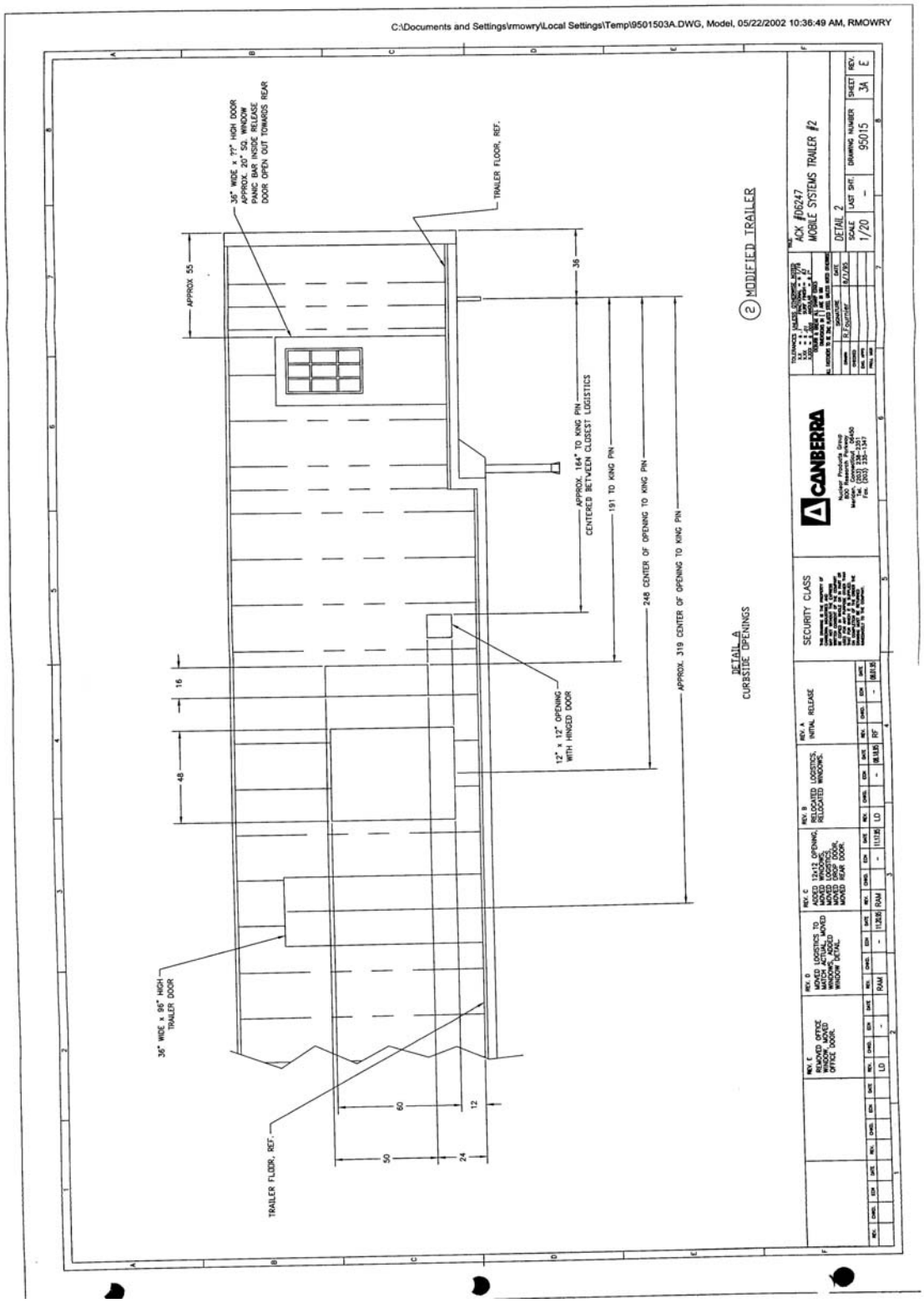
Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)

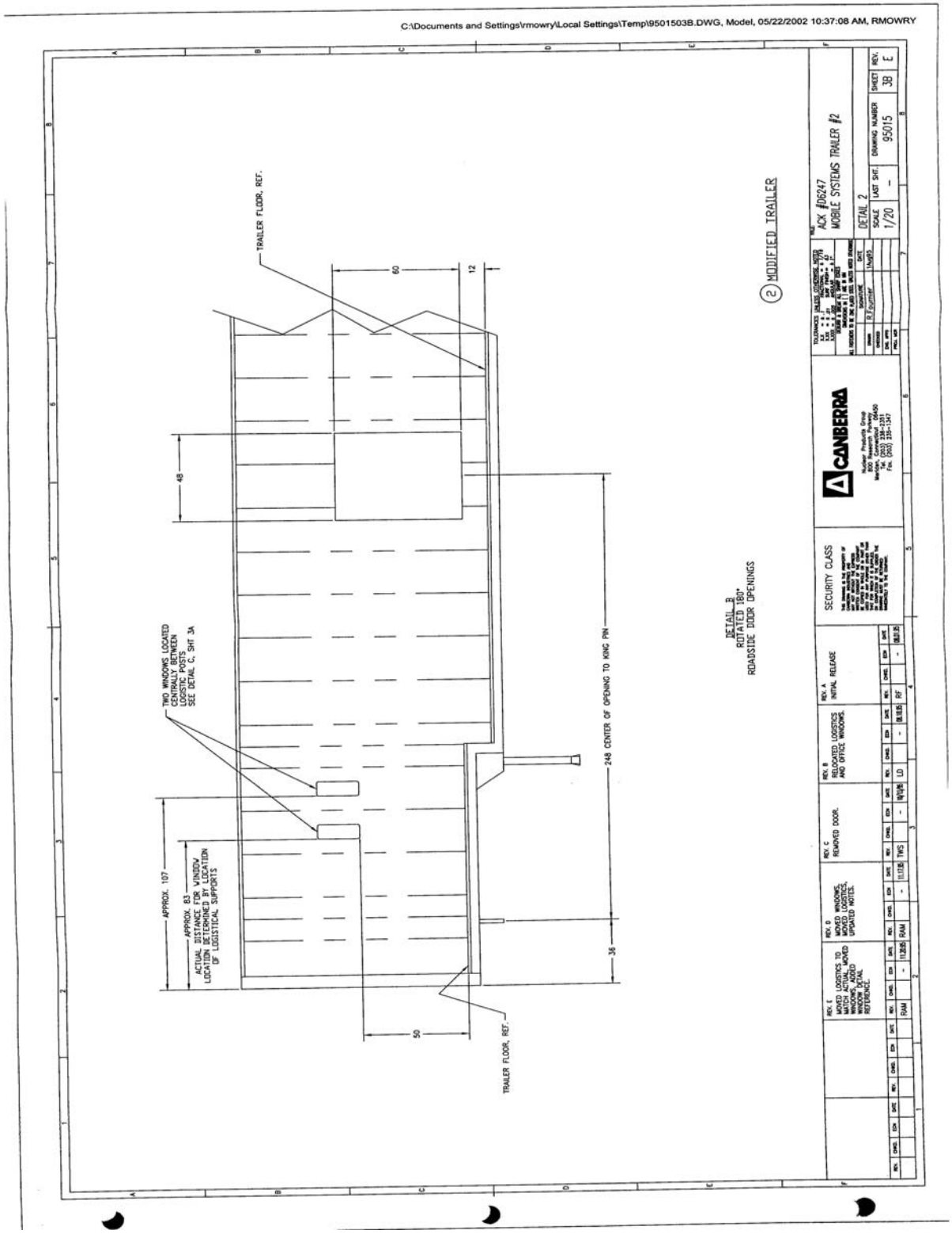


Attachment 2 – Drawings (Continued)

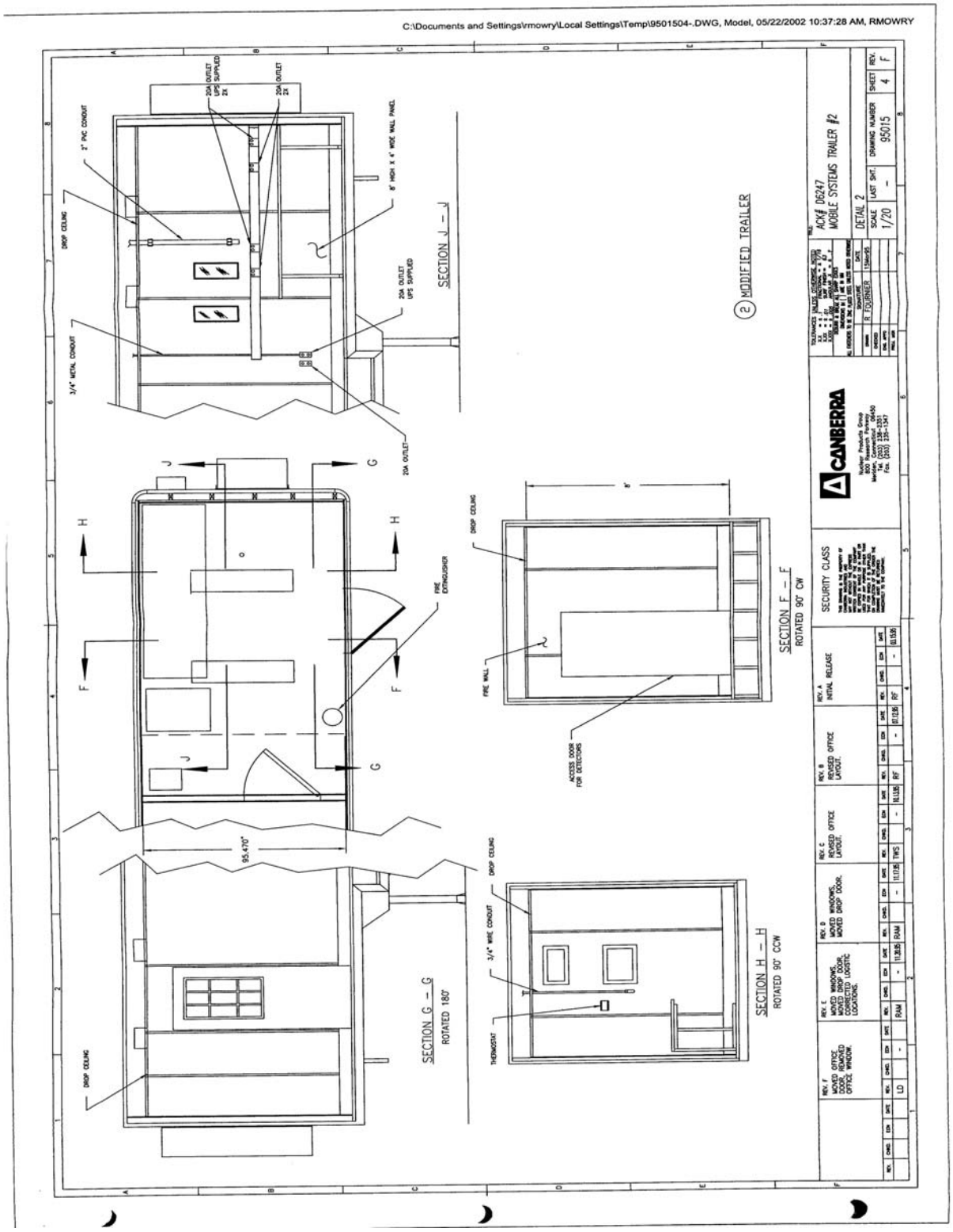


Controlled
Copy

Attachment 2 – Drawings (Continued)

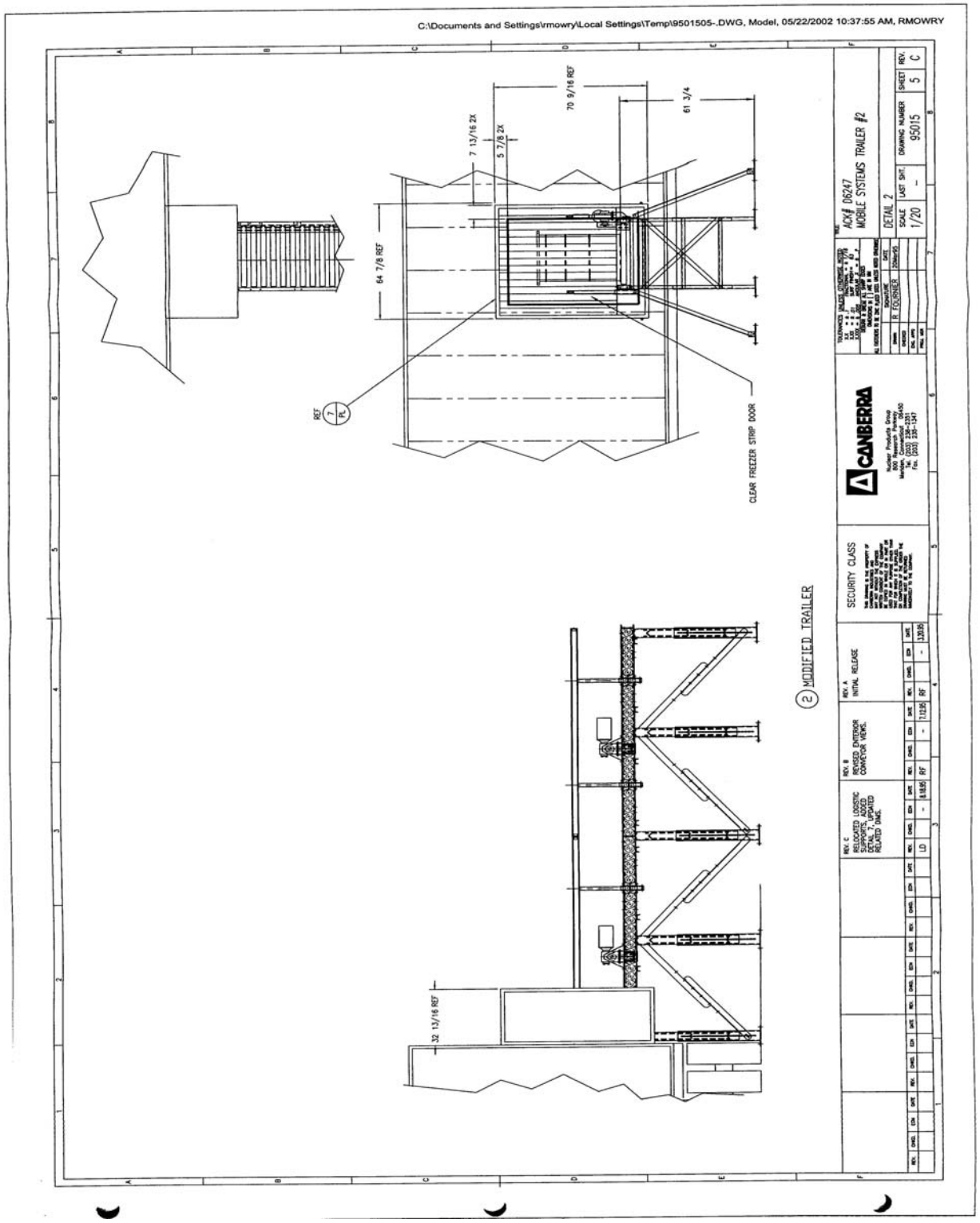


Attachment 2 – Drawings (Continued)

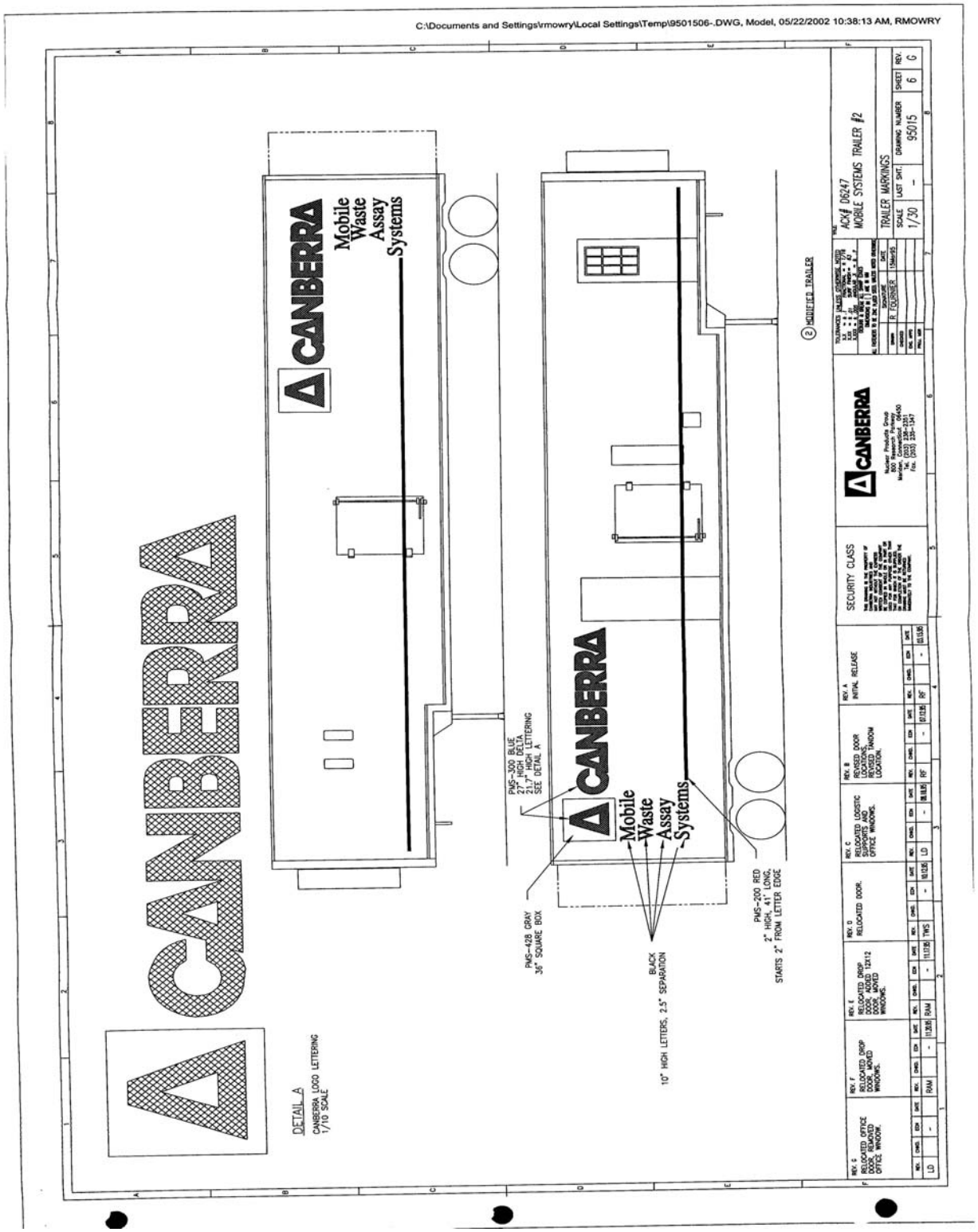


Controlled
Copy

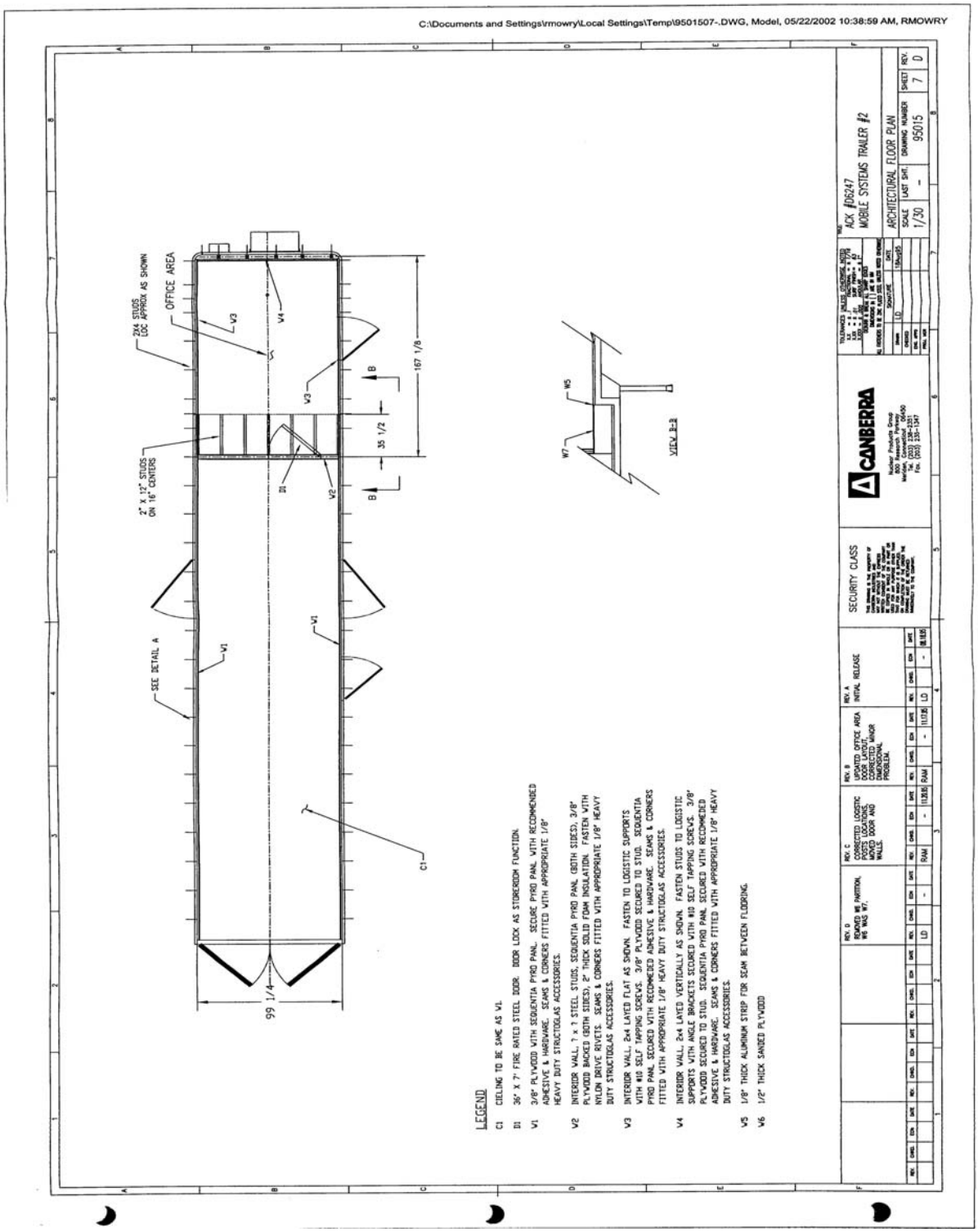
Attachment 2 – Drawings (Continued)



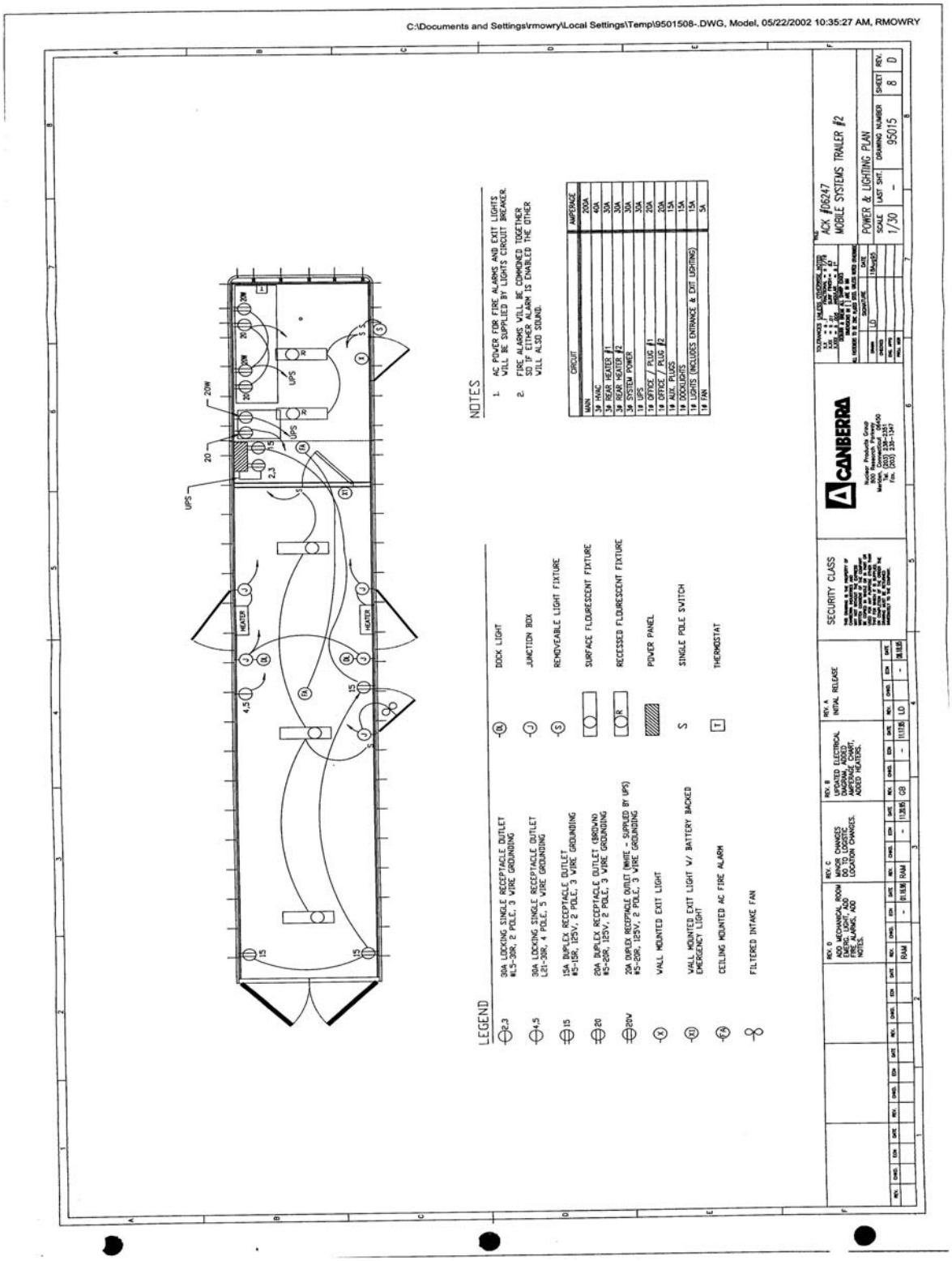
Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)

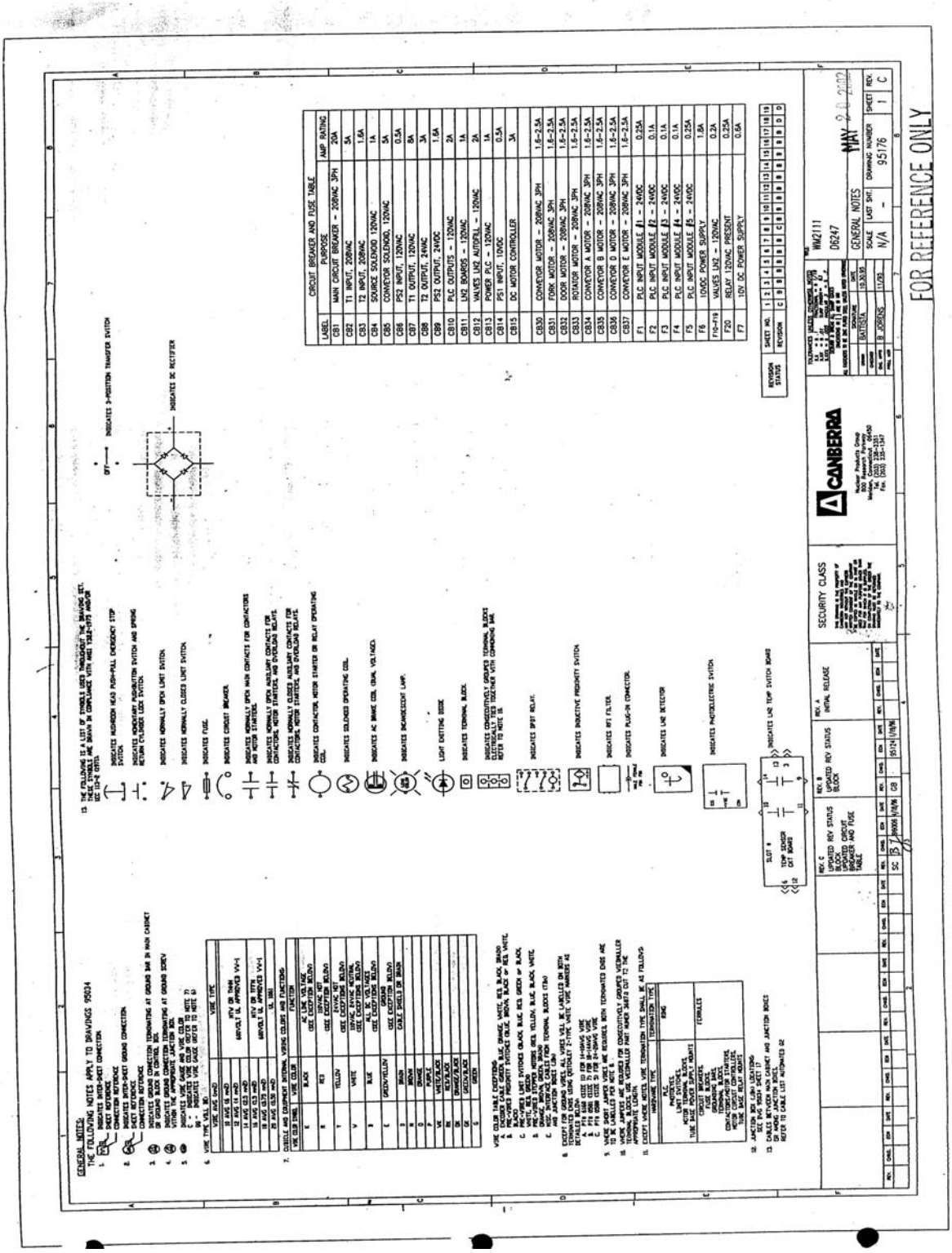


Attachment 2 – Drawings (Continued)

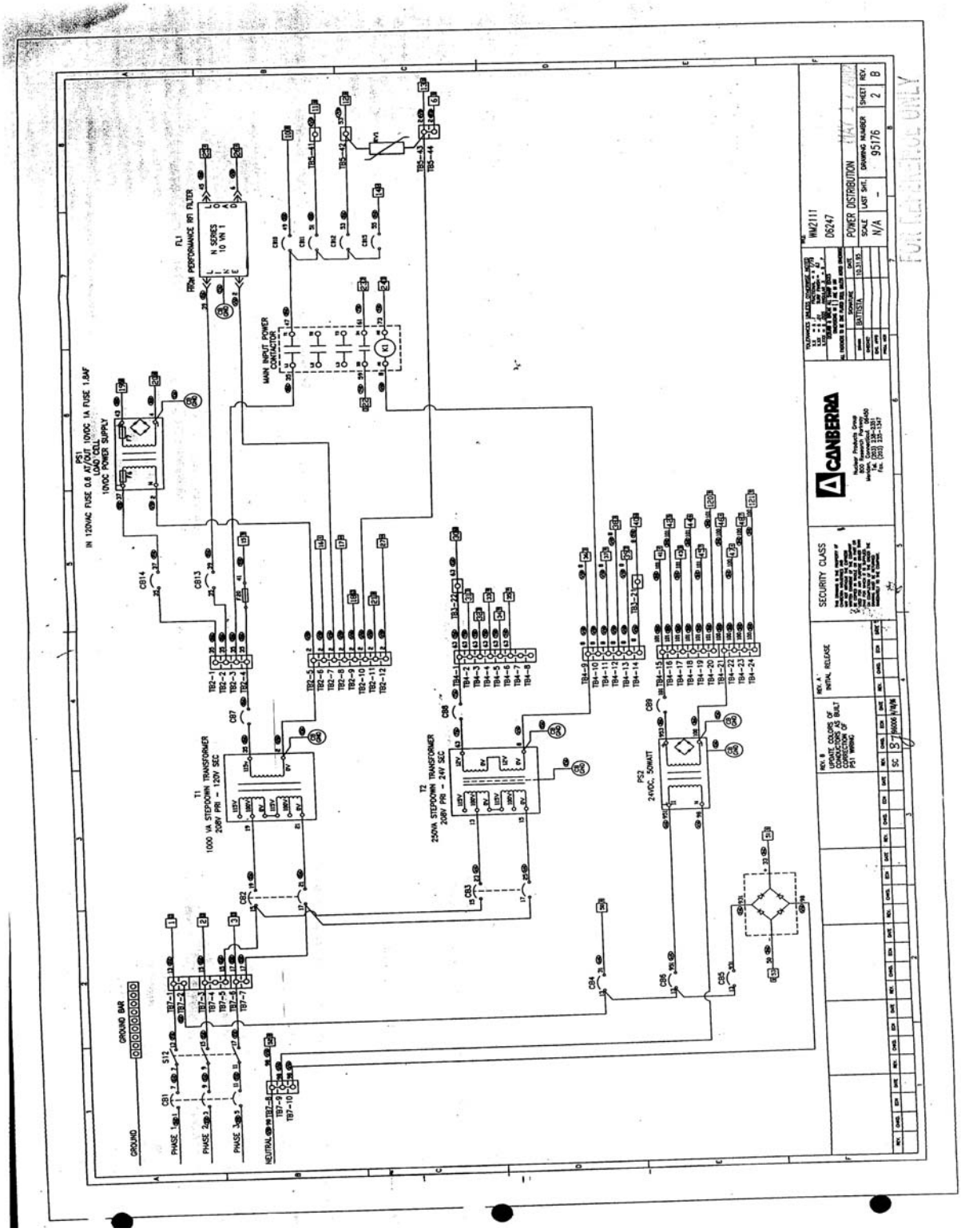


Controlled
Copy

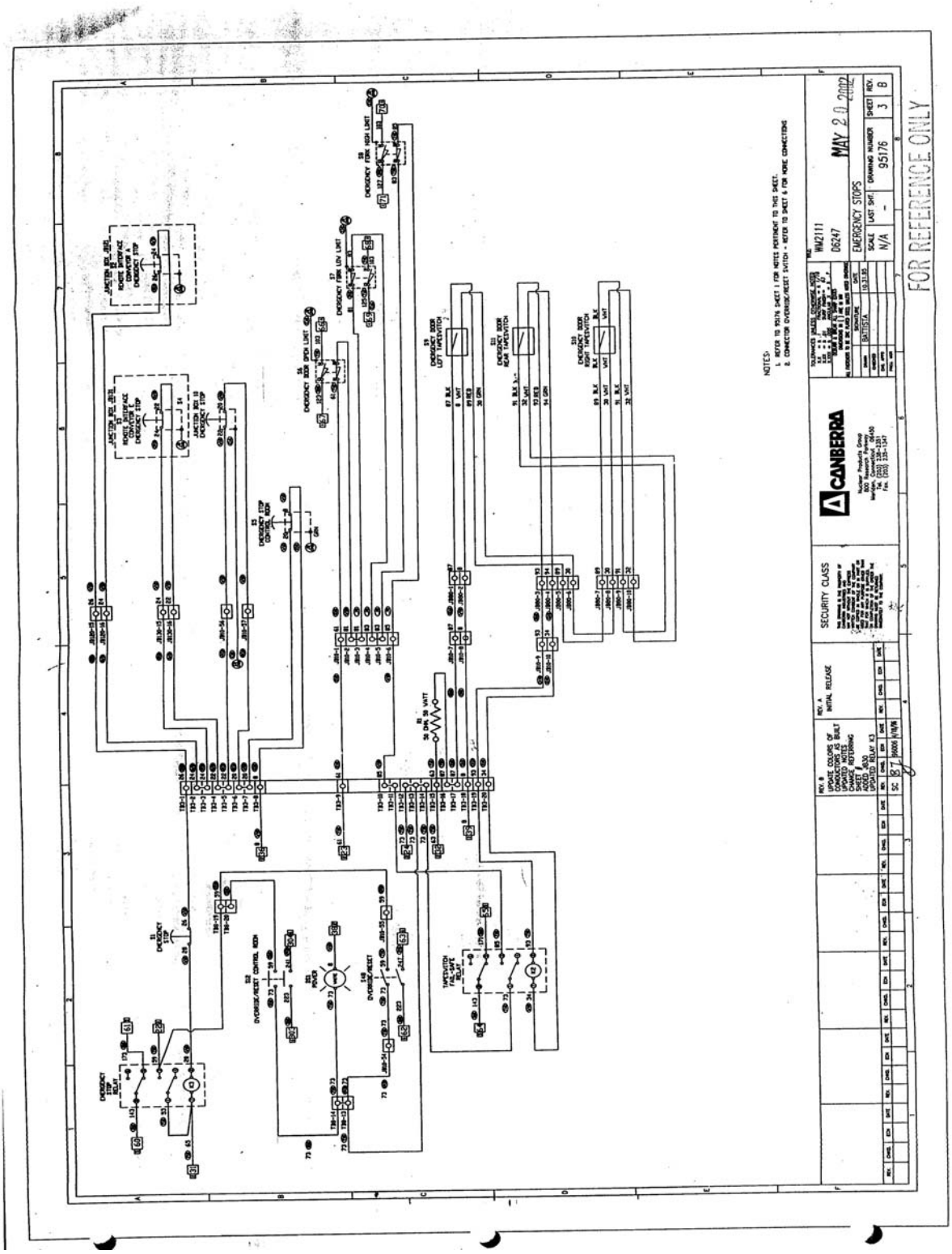
Attachment 2 – Drawings (Continued)



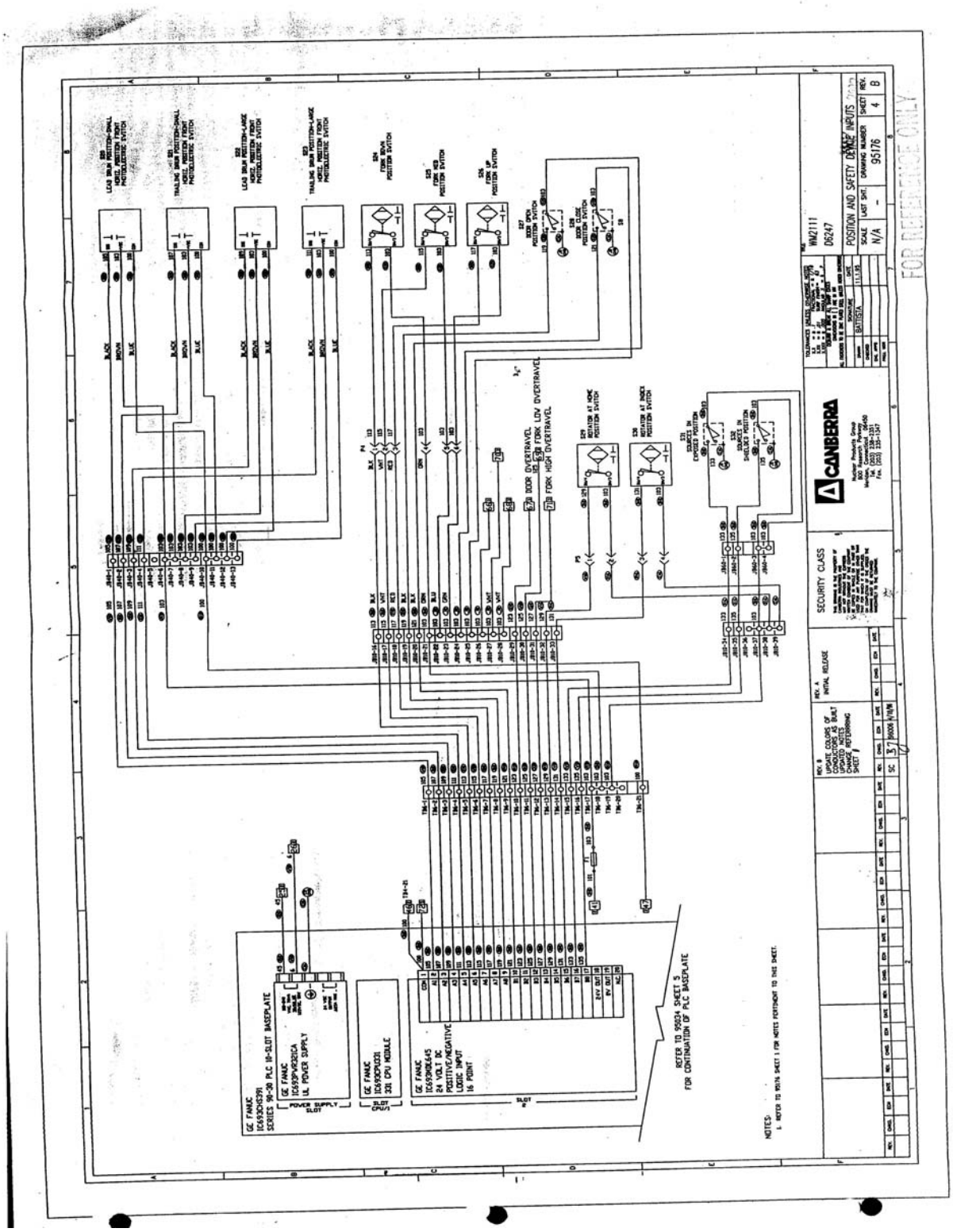
Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)

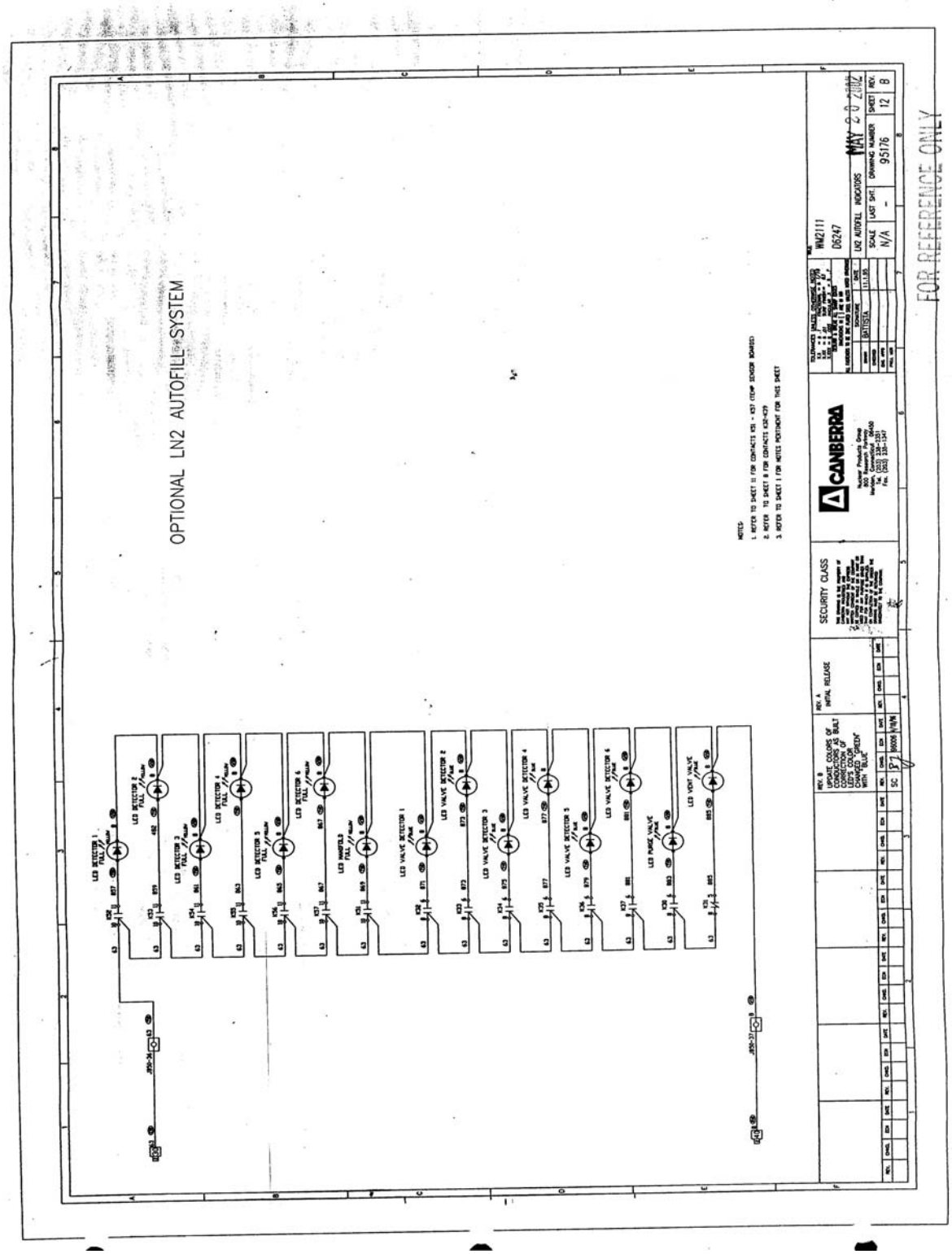


Attachment 2 – Drawings (Continued)



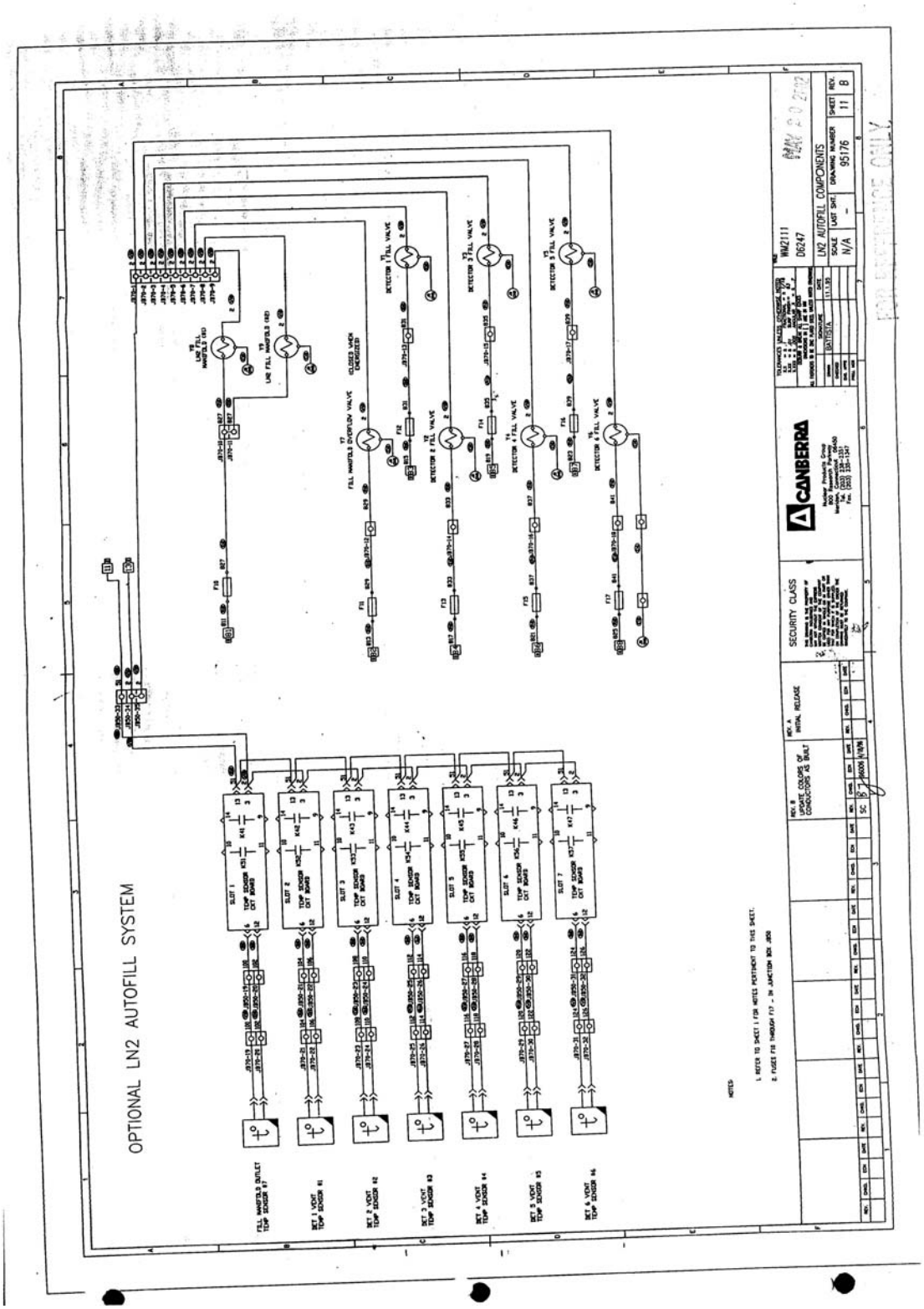
Controlled
Copy

Attachment 2 – Drawings (Continued)

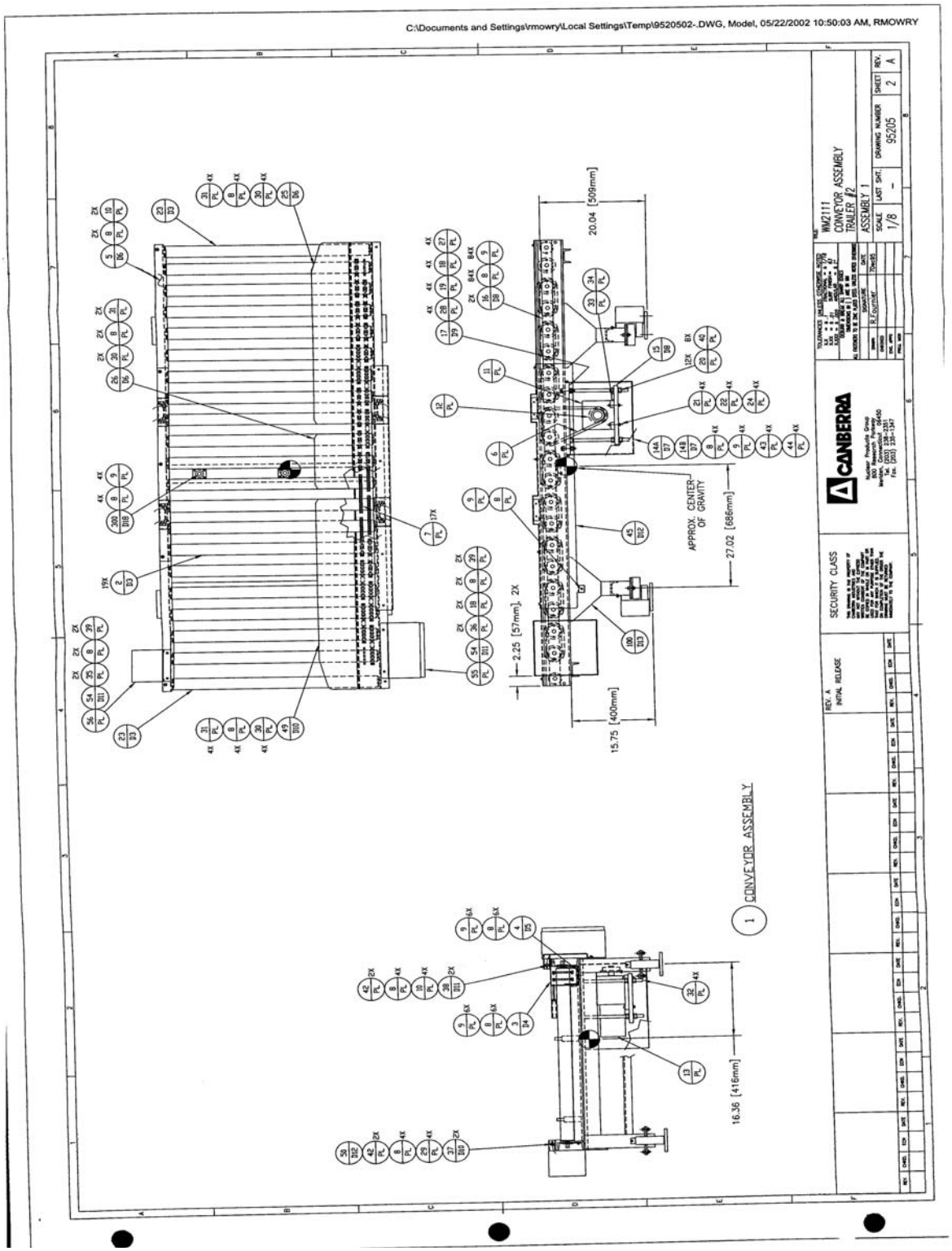


Controlled
Copy

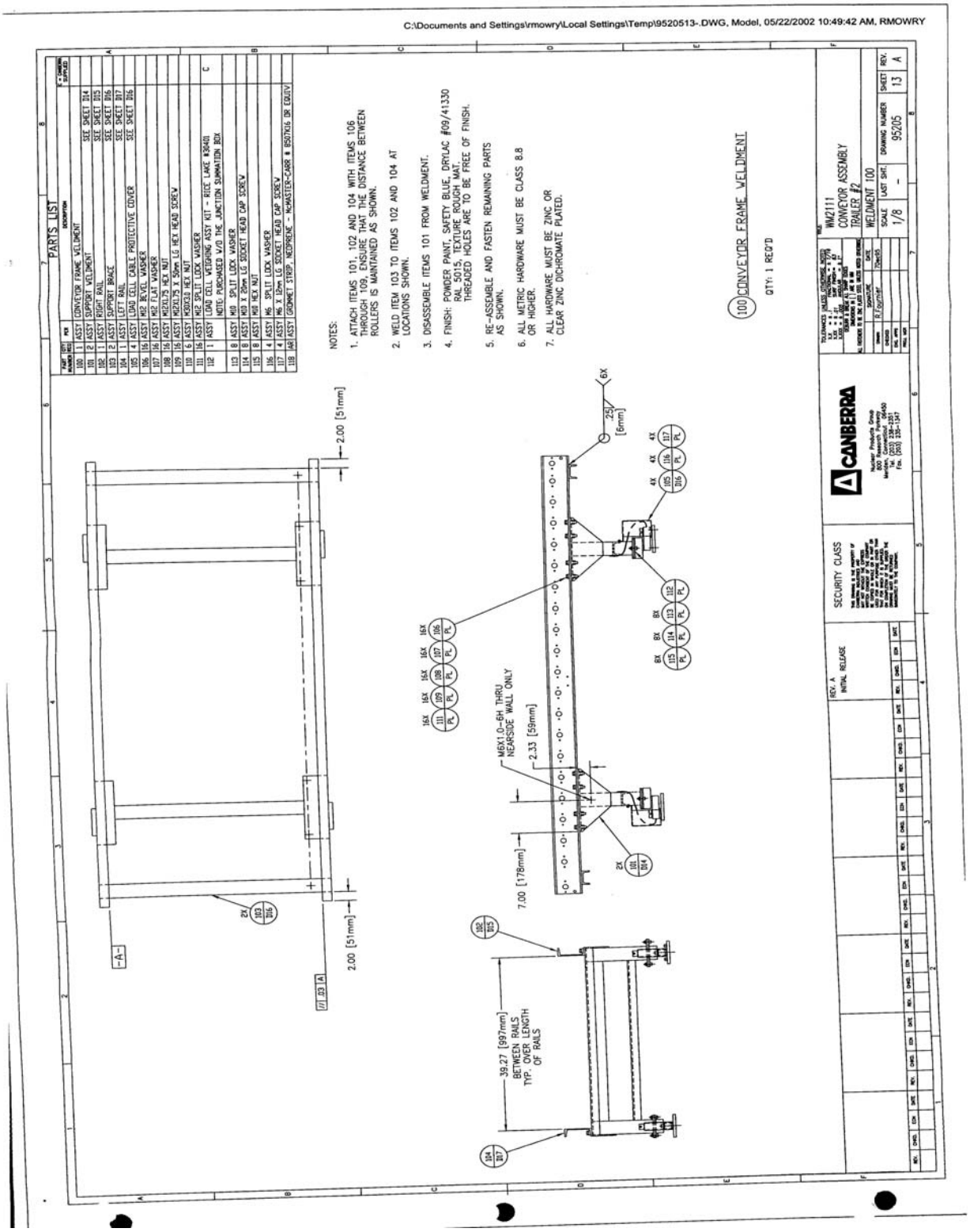
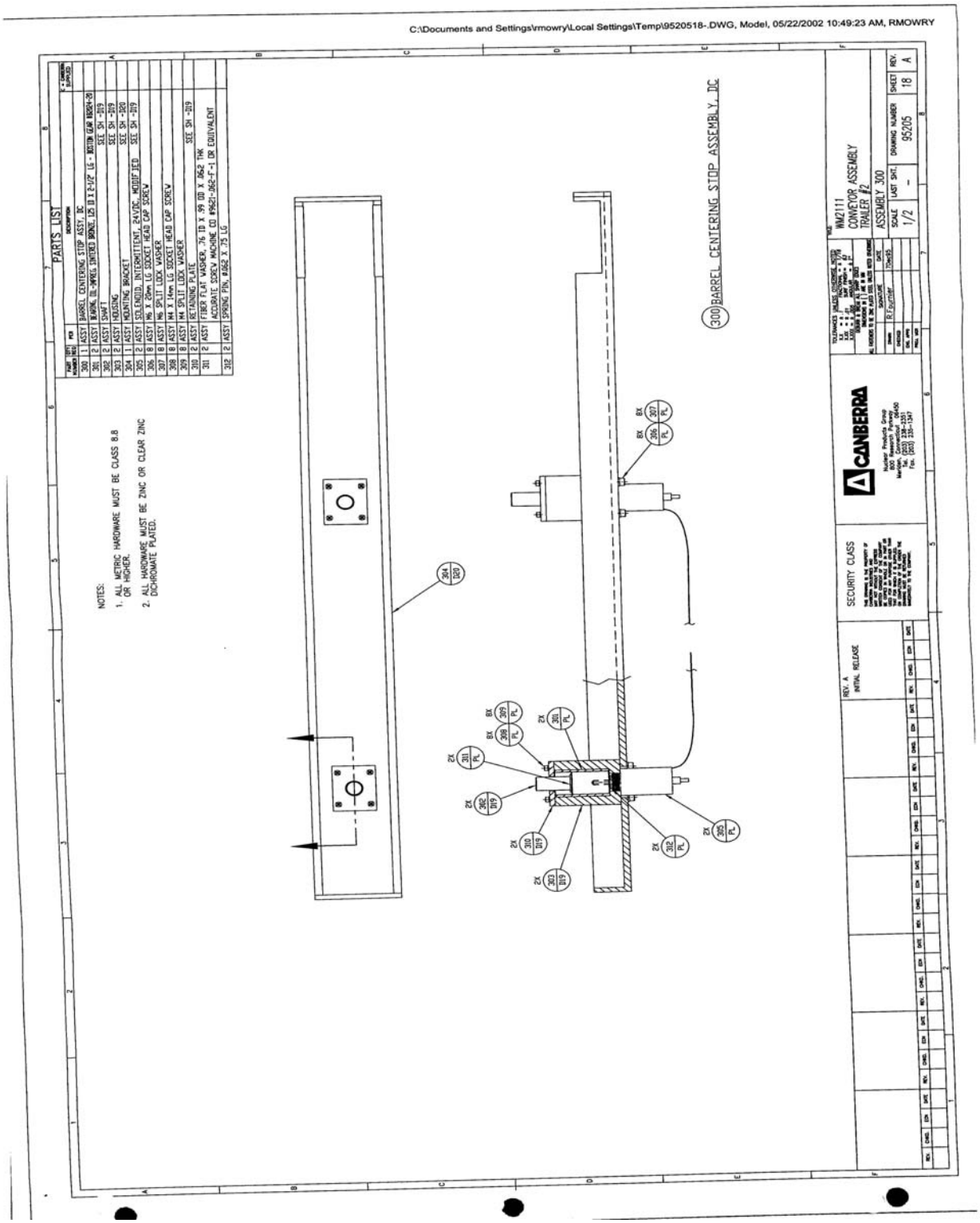
Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)



Attachment 2 – Drawings (Continued)