### APPENDIX B

#### 2012 BUILDING CODE SUMMARY FOR ALL COMMERCIAL PROJECTS

(EXCEPT ONE- AND TWO-FAMILY DWELLINGS AND TOWNHOMES)

(Reproduce the following data on the building plans sheet 1 or 2)

| Name of Project: |  |
| Address: |  |
| Proposed Use: |  |
| Owner/Authorized Agent: |  |
| Phone #: ( ) |  |
| E-Mail: |  |
| Owned By: |  |
| City/County |  |
| Private |  |
| State |  |
| Code Enforcement Jurisdiction: |  |
| City |  |
| County |  |
| State |  |

### LEAD DESIGN PROFESSIONAL:

<table>
<thead>
<tr>
<th>DESIGNER</th>
<th>FIRM</th>
<th>NAME</th>
<th>LICENSE #</th>
<th>TELEPHONE #</th>
<th>E-MAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Civil</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire Alarm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plumbing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprinkler-Standpipe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retaining Walls &gt;5 High</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2012 EDITION OF NC CODE FOR:

- New Construction
- Addition
- Upfit

### EXISTING:

- Reconstructions
- Alteration
- Repair
- Renovation

### CONSTRUCTED: (date)

- ORIGINAL USE(S) (Ch. 3):

### RENOVATED: (date)

- CURRENT USE(S) (Ch. 3):

### PROPOSED USE(S) (Ch. 3):

### BUILDING DATA

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(check all that apply)</td>
<td>J-B</td>
<td>J-B</td>
<td>J-B</td>
<td>J-B</td>
<td>J-B</td>
<td>J-B</td>
</tr>
<tr>
<td>Sprinklers:</td>
<td>No</td>
<td>Partial</td>
<td>No</td>
<td>NEPA 13</td>
<td>NEPA 13R</td>
<td>NEPA 13D</td>
</tr>
<tr>
<td>Standpipes:</td>
<td>No</td>
<td>Yes</td>
<td>Class</td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>Fire District:</td>
<td>No</td>
<td>Yes</td>
<td>Primary</td>
<td>Flood Hazard Area:</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Building Height: (feet)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross Building Area:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Floor

<table>
<thead>
<tr>
<th>Existing (sq ft)</th>
<th>New (sq ft)</th>
<th>Subtotal</th>
</tr>
</thead>
<tbody>
<tr>
<td>6th Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2nd Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mezzanine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st Floor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### TOTAL
### ALLOWABLE AREA

**Occupancy:**
- Business: U
- Educational: U
- Factory: F-1 Moderate, F-2 Low
- Hazardous: H-1 Detonate, H-2 Deflagrate, H-3 Combust, H-4 Health, H-5 HP
- Institutional: I-1, I-2, I-3, I-4
- I-3 Condition: I-1, I-2, I-3, I-4
- Mercantile: U
- Residential: R-1, R-2, R-3, R-4
- Storage: S-1 Moderate, S-2 Low, S3 High-piled
  - Parking Garage: U
  - Open: U
  - Enclosed: U
  - Repair Garage: U
- Utility and Miscellaneous: U

**Accessory Occupancies:**
- Business: U
- Educational: U
- Factory: F-1 Moderate, F-2 Low
- Hazardous: H-3 Detonate, H-2 Deflagrate, H-3 Combust, H-4 Health, H-5 HP
- Institutional: I-1, I-2, I-3, I-4
- I-3 Condition: I-1, I-2, I-3, I-4
- Mercantile: U
- Residential: R-1, R-2, R-3, R-4
- Storage: S-1 Moderate, S-2 Low, S3 High-piled
  - Parking Garage: U
  - Open: U
  - Enclosed: U
  - Repair Garage: U
- Utility and Miscellaneous: U

**Accessory Occupancies:**
- Furnace room where any piece of equipment is over 400,000 Btu per hour input
- Rooms with boilers where the largest piece of equipment is over 15 psi and 10 horsepower
- Refrigerant machine room
- Hydrogen cutoff rooms, not classified as Group H
- Incinerator rooms
- Paint shops, not classified as Group H, located in occupancies other than Group F
- Laboratories and vocational shops, not classified as Group H, located in a Group E or I-2 occupancy
- Laundry rooms over 100 square feet
- Group I-3 cells equipped with padded surfaces
- Group I-2 waste and linen collection rooms
- Waste and linen collection rooms over 100 square feet
- Stationary storage battery systems having a liquid electrolyte capacity of more than 50 galls, or a lithium-ion capacity of 1,000 pounds used for facility standby power, emergency power or uninterrupted power supplies
- Rooms containing fire pumps
- Group I-2 storage rooms over 100 square feet
- Group I-2 commercial kitchens
- Group I-2 laundries equal to or less than 100 square feet
- Group I-2 rooms or spaces that contain fuel-fired heating equipment

**Special Uses:**
- 402
- 403
- 404
- 405
- 406
- 407
- 408
- 409
- 410
- 411
- 412
- 413
- 414
- 415
- 416
- 417
- 418
- 419
- 420
- 421
- 422
- 423
- 424
- 425
- 426
- 427

**Special Provisions:**
- 509.2
- 509.3
- 509.4
- 509.5
- 509.6
- 509.7
- 509.8
- 509.9

*continued*
ALLOWABLE AREA—cont'd

Mixed Occupancy:

☐ No   ☐ Yes  Separation: ___ Hr  Exception: ______________

☐ Incidental Use Separation (508.2.5)
This separation is not exempt as a Nonseparated Use (see exceptions).

☐ Nonseparated Use (508.3.2)
The required type of construction for the building shall be determined by applying the height and area limitations for each of the applicable occupancies to the entire building. The most restrictive type of construction, so determined, shall apply to the entire building.

☐ Separated Use (508.3.3) See below for area calculations.
For each story, the area of the occupancy shall be such that the sum of the ratios of the actual floor area of each use divided by the allowable floor area for each use shall not exceed 1.

\[
\frac{\text{Actual Area of Occupancy } A}{\text{Allowable Area of Occupancy } A} + \frac{\text{Actual Area of Occupancy } B}{\text{Allowable Area of Occupancy } B} \leq 1
\]

<table>
<thead>
<tr>
<th>STORY NO.</th>
<th>DESCRIPTION AND USE</th>
<th>(A) BLDG AREA PER STORY (ACTUAL)</th>
<th>(B) TABLE 503(^3) AREA</th>
<th>(C) AREA FOR FRONTAGE INCREASE(^1)</th>
<th>(D) AREA FOR SPRINKLER INCREASE(^2)</th>
<th>(E) ALLOWABLE AREA OR UNLIMITED(^1)</th>
<th>(F) MAXIMUM BUILDING AREA(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Frontage area increases from Section 506.2 are computed thus:
a. Perimeter which fronts a public way or open space having 20 feet minimum width = _____ (F)
b. Total Building Perimeter = _____ (F)
c. Ratio \( F/P \) = _____ (F/P)
d. Width of minimum width of public way = _____ \( W \)
e. Percent of frontage increase \( P = 100 \times \frac{F/P - 0.25}{W/20} \) = _____ (\%)

2. The sprinkler increase per Section 506.3 is as follows:
a. Multi-story building \( S = 200 \) percent
b. Single story building \( S = 300 \) percent

3. Unlimited area applicable under conditions of Section 507.

4. Maximum Building Area = total number of stories in the building \( \times E \) (506.4).

5. The maximum area of open parking garages must comply with Table 408.3.5. The maximum area of all traffic control areas must comply with Table 412.1.2.
## Allowable Height

<table>
<thead>
<tr>
<th>Type of Construction</th>
<th>ALLOWABLE (TABLE 593)</th>
<th>INCREASE FOR SPRINKLERS</th>
<th>SHOWN ON PLANS</th>
<th>CODE REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building Height in Feet</td>
<td>Feet + 20' =</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building Height in Stories</td>
<td>Stories + 1 =</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Fire Protection Requirements

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>FIRE SEPARATION DISTANCE (FEET)</th>
<th>RATING</th>
<th>PROVIDED (WALL THICKNESS - REDUCTION)</th>
<th>DETAIL # AND SHEET #</th>
<th>DESIGN # FOR RATED ASSEMBLY</th>
<th>DESIGN # FOR RATED PENETRATION</th>
<th>DESIGN # FOR RATED JOINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural Frame</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearing Walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>North</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>East</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>West</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>South</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor Construction</td>
<td>Including supporting beams and joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof Construction</td>
<td>Including supporting beams and joists</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft Enclosures — Exit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaft Enclosures — Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corridor Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occupancy Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Party/Fire Wall Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoke Barrier Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tenant Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incidental Use Separation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Indicate section number permitting reduction
LIFE SAFETY SYSTEM REQUIREMENTS

Emergency Lighting: ☐ No ☑ Yes
Exit Signs: ☐ No ☑ Yes
Fire Alarm: ☐ No ☑ Yes
Smoke Detection Systems: ☐ No ☑ Yes ☐ Partial
Panic Hardware: ☐ No ☑ Yes

LIFE SAFETY PLAN REQUIREMENTS

Life Safety Plan Sheet #: __________________________
☐ Fire and/or smoke rated wall locations (Chapter 7)
☐ Assumed and real property line locations
☐ Exterior wall opening area with respect to distance to assumed property lines (705.8)
☐ Existing structures within 30 feet of the proposed building
☐ Occupancy types for each area as it relates to occupant load calculation (Table 1004.1.1)
☐ Occupant loads for each area
☐ Exit access travel distances (1018)
☐ Common path of travel distances (1014.3 & 1028.8)
☐ Dead end lengths (1018.4)
☐ Clear exit widths for each exit door
☐ Maximum calculated occupant load capacity each exit door can accommodate based on egress width (1005.1)
☐ Actual occupant load for each exit door
☐ A separate schematic plan indicating where fire rated floor/ceiling and/or roof structure is provided for purposes of occupancy separation
☐ Location of doors with panic hardware (1008.1.10)
☐ Location of doors with delayed egress locks and the amount of delay (1008.1.9.7)
☐ Location of doors with electromagnetic egress locks (1008.1.9.8)
☐ Location of doors equipped with hold-open devices
☐ Location of emergency escape windows (1029)
☐ The square footage of each fire area (902)
☐ The square footage of each smoke compartment (407.4)
☐ Note any code exceptions or table notes that may have been utilized regarding the items above

ACCESSIBLE DWELLING UNITS
(SECTION 1107)

<table>
<thead>
<tr>
<th>TOTAL UNITS</th>
<th>ACCESSIBLE UNITS REQUIRED</th>
<th>ACCESSIBLE UNITS PROVIDED</th>
<th>TYPE A UNITS REQUIRED</th>
<th>TYPE A UNITS PROVIDED</th>
<th>TYPE B UNITS REQUIRED</th>
<th>TYPE B UNITS PROVIDED</th>
<th>TOTAL ACCESSIBLE UNITS PROVIDED</th>
</tr>
</thead>
</table>

ACCESSIBILITY PARKING
(SECTION 1106)

<table>
<thead>
<tr>
<th>LOT OR PARKING AREA</th>
<th>TOTAL # OF PARKING SPACES REQUIRED</th>
<th># OF ACCESSIBLE SPACES PROVIDED</th>
<th>VAN SPACES WITH 132&quot; ACCESS AISLE</th>
<th>TOTAL # ACCESSIBLE PROVIDED</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>REGULAR WITH 5' ACCESS AISLE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PROVIDED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2012 NORTH CAROLINA ADMINISTRATIVE CODE AND POLICIES 27
APPENDIX B

STRUCTURAL DESIGN

DESIGN LOADS:

Importance Factors:
Wind (f_w) ______
Snow (f_s) ______
Seismic (f_s) ______

Live Loads:
Roof ______ psf
Mezzanine ______ psf
Floor ______ psf

Ground Snow Load: ______ psf

Wind Load:
Basic Wind Speed ______ mph (ASCE-7)
Exposure Category ______
Wind Base Shears (for MWFRS) V_s = ______ V_r = ______

SEISMIC DESIGN CATEGORY:
- q A q B q C q D

Provide the following Seismic Design Parameters:

Occupancy Category (Table 1604.5)
- q I q II q III q IV

Spectral Response Acceleration
S_s ______ %g
S_t ______ %g

Site Classification (Table 1613.5.2)
- q A q B q C q D q E q F

Data Source
- q Field Test q Presumptive q Historical Data

Basic structural system (check one)
- q Bearing Wall q Dual w/Special Moment Frame
- q Building Frame q Dual w/Intermediate R/C or Special Steel
- q Moment Frame q Inverted Pendulum

Seismic base shear: V_s = ______ V_r = ______

Analysis Procedure:
- q Simplified q Equivalent Lateral Force q Dynamic

Architectural, Mechanical, Components anchored?
- q Yes q No

LATERAL DESIGN CONTROL:
- q Earthquake q Wind

SOIL BEARING CAPACITIES:

Field Test (provide copy of test report) ______ psf

Presumptive Bearing capacity ______ psf

Pile size, type, and capacity ______

SPECIAL INSPECTIONS REQUIRED:
- q Yes q No

PLUMBING FIXTURE REQUIREMENTS

(TABLE 2002.1)

<table>
<thead>
<tr>
<th>USE</th>
<th>WATERCLOSETS</th>
<th>URNALS</th>
<th>LAVATORIES</th>
<th>SHOWERS/</th>
<th>DRINKING FOUNTAINS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MALE</td>
<td>FEMALE</td>
<td>MALE</td>
<td>FEMALE</td>
<td>TUBS</td>
</tr>
<tr>
<td>SPACE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EXISTING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NEW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REQUIRED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SPECIAL APPROVALS

Special approval: (Local Jurisdiction, Department of Insurance, OSC, DPI, DHHS, ICC, etc., describe below)
ENERGY REQUIREMENTS:

The following data shall be considered minimum and any special attribute required to meet the energy code shall also be provided. Each Designer shall furnish the required portion of the project information for the plan data sheet. If performance method, state the annual energy cost for the standard reference design versus the annual energy cost for the proposed design.

Climate Zone:  3  4  5

Method of Compliance:

- Prescriptive (Energy Code)
- Performance (Energy Code)
- Prescriptive (ASHRAE 90.1)
- Performance (ASHRAE 90.1)

THERMAL ENVELOPE

Roof/ceiling Assembly (each assembly)
- Description of assembly: _____________________________
- U-Value of total assembly: ___________________________
- R-Value of insulation: ______________________________
- Skylights in each assembly: __________________________
- U-Value of skylight: ________________________________
- total square footage of skylights in each assembly: __________

Exterior Walls (each assembly)
- Description of assembly: _____________________________
- U-Value of total assembly: ___________________________
- R-Value of Insulation: ______________________________
- Openings (windows or doors with glazing)
  - U-Value of assembly: ______________________________
  - Solar heat gain coefficient:
  - Projection factor: ________________________________
  - Door R Values: _________________________________

Walls below grade (each assembly)
- Description of assembly: _____________________________
- U-Value of total assembly: ___________________________
- R-Value of insulation: ______________________________

Floors over unconditioned space (each assembly)
- Description of assembly: _____________________________
- U-Value of total assembly: ___________________________
- R-Value of Insulation: ______________________________

Floors slab on grade
- Description of assembly: _____________________________
- U-Value of total assembly: ___________________________
- R-Value of insulation: ______________________________
- Horizontal/Vertical requirement: ______________________
- Slab heated: _____________________________________
MECHANICAL SUMMARY

MECHANICAL SYSTEMS, SERVICE SYSTEMS AND EQUIPMENT

Thermal Zone
- Winter dry bulb:
- Summer dry bulb:

Interior design conditions
- Winter dry bulb:
- Summer dry bulb:
- Relative humidity:

Building heating load:

Building cooling load:

Mechanical Spacing Conditioning System

Unitary
- Description of unit:
- Heating efficiency:
- Cooling efficiency:
- Size category of unit:

Boiler
- Size category. If oversized, state reason:

Chiller
- Size category. If oversized, state reason:

List equipment efficiencies:

---

ELECTRICAL SUMMARY

ELECTRICAL SYSTEM AND EQUIPMENT

Method of Compliance:
- Energy Code:
  - Prescriptive
  - Performance
- ASHRAE 90.1:
  - Prescriptive
  - Performance

Lighting schedule (each fixture type)
- Lamp type required in fixture
- Number of lamps in fixture
- Ballast type used in fixture
- Number of ballasts in fixture
- Total wattage per fixture
- Total interior wattage specified vs. allowed (whole building or space by space)
- Total exterior wattage specified vs. allowed

Additional Prescriptive Compliance
- 506.2.1 More Efficient Mechanical Equipment
- 506.2.2 Reduced Lighting Power Density
- 506.2.3 Energy Recovery Ventilation Systems
- 506.2.4 Higher Efficiency Service Water Heating
- 506.2.5 On-site Supply of Renewable Energy
- 506.2.6 Automatic Daylighting Control Systems