

# Understanding Variation with Process Behavior Charts (Control Charts)

There are several different kinds of control charts. The chart that is probably the best for use in local government is known as the Individual Moving Range chart or I-MR or sometimes X-MR. It is actually two separate charts that should be prepared and used together. The charts are meant to examine the process behavior of some data over time to determine if it is predictable process and what amount variation is part of the process. While the chart starts off with the assumption the data is “in control” one of the key purposes of the chart is to determine if that is the case.

Imagine an operation where we are concerned with actual waiting time. The goal is for waiting times to be under five minutes. Twenty-four consecutive data points were collected and are shown at the right. The I-MR chart is constructed with the following steps.

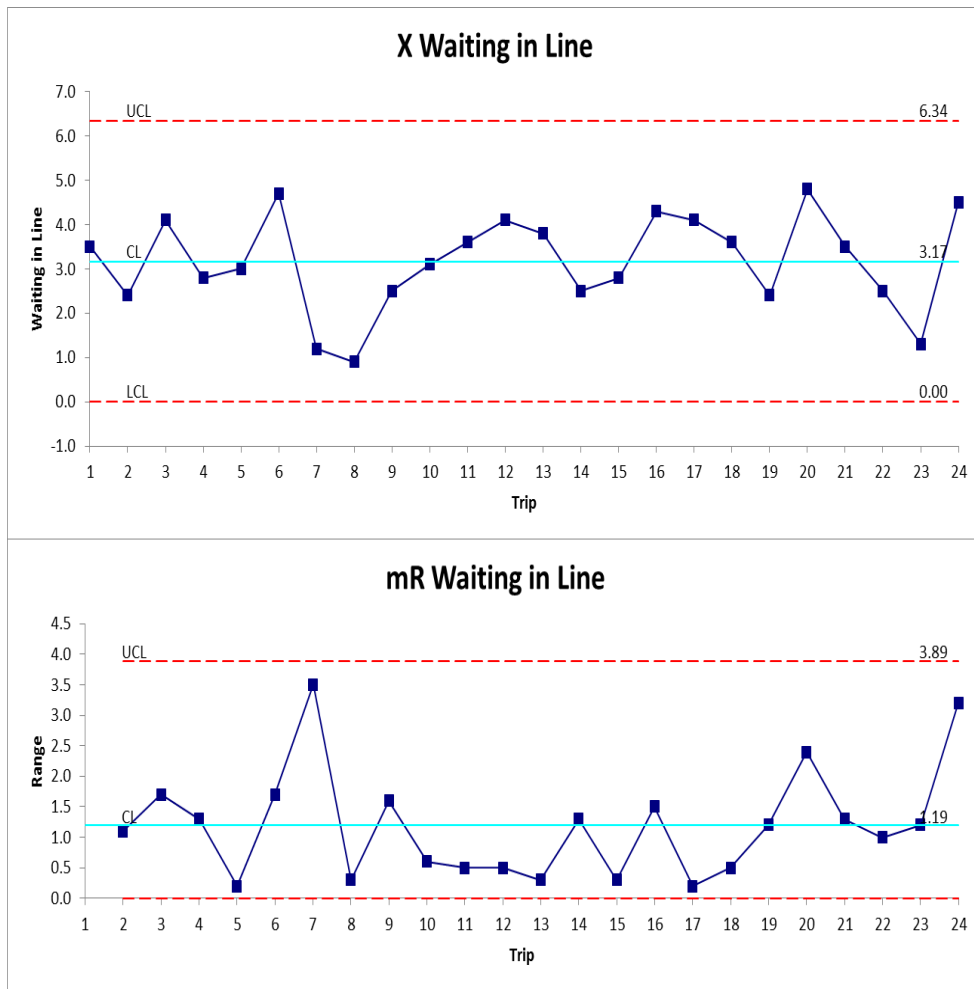
1. Calculate the range which is the absolute value of the difference between the current point and the previous point.
2. Find the average of the ranges.
3. Create an upper limit for the ranges by multiplying the average range by 3.268 and add to the average range.
4. Plot the range chart.
5. Find the average for the actual data.
6. Calculate upper and lower control limits for the actual data with the formula  $\text{DataAverage} \pm 2.66 * \text{AverageRange}$
7. Plot the data chart with the data line and the upper and lower control limits.

Trip	Waiting in Line	Range
1	3.5	
2	2.4	1.1
3	4.1	1.7
4	2.8	1.3
5	3	0.2
6	4.7	1.7
7	1.2	3.5
8	0.9	0.3
9	2.5	1.6
10	3.1	0.6
11	3.6	0.5
12	4.1	0.5
13	3.8	0.3
14	2.5	1.3
15	2.8	0.3
16	4.3	1.5
17	4.1	0.2
18	3.6	0.5
19	2.4	1.2
20	4.8	2.4
21	3.5	1.3
22	2.5	1
23	1.3	1.2
24	4.5	3.2
Average	3.17	1.19

The resulting Range and Data chart are shown on the next page. Interpreting the charts.

1. The range chart tells us the average movement from period to period is 1.19 minutes and the maximum change in waiting time from one period to the next we should see, assuming a predictable process, is 3.89 minutes.
2. No points on the range chart are past the 3.89 control limit so there are no points of concern on that range chart. The changes from one period to the next are predictable.
3. On the waiting time data chart, we see that the times while varying all lie within the control limits. We would conclude this is a stable and predictable process.
4. The average waiting time is 3.17 minutes and the maximum that would be expected is 6.34 minutes and we might see instances of zero waiting time.
5. Unless changes take place, we can use this for making predictions going forward and checking when we have problems.

# Process Improvement Tools



Data or X Chart

Control Limits

Actual Data

Average or Center Line

Range Chart

Upper Range Limit

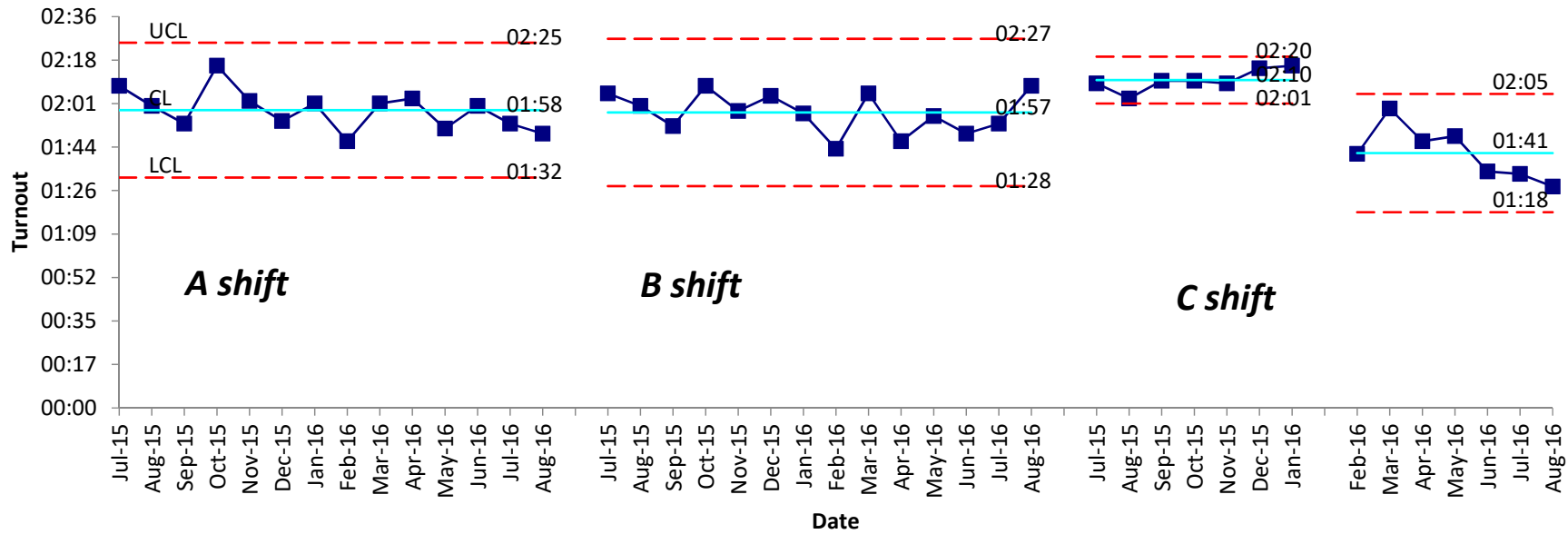
Range

Average Range

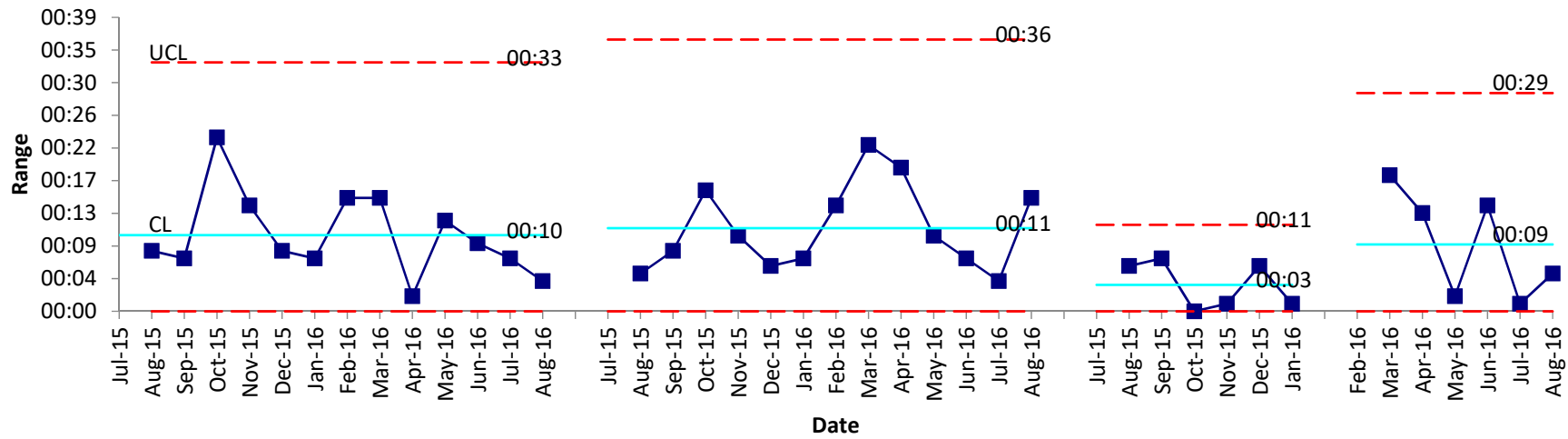
Control charts can be calculated with a little work in Excel. The template included with class will do a basic first cut I-MR chart. Several companies sell add-ins for Excel which help you make the process of creating controls very easy. Possible vendors include:

1. [www.Qimacros.com](http://www.Qimacros.com)
2. [www.spcforexcel.com](http://www.spcforexcel.com)
3. [www.sigmaxl.com/](http://www.sigmaxl.com/)
4. [www.sigmazone.com](http://www.sigmazone.com)
5. [http://www.pipproducts.com/qi\\_charts.html](http://www.pipproducts.com/qi_charts.html)

## X Turnout Times for Engine Company by Shift

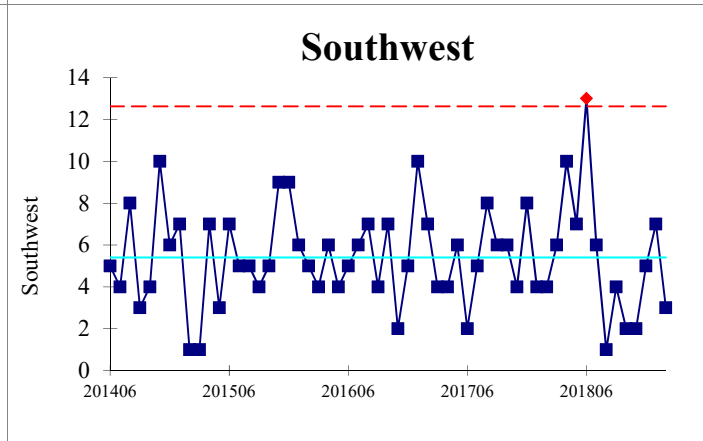
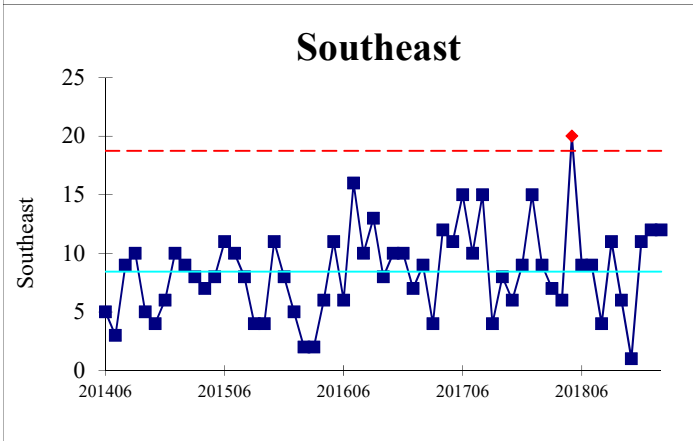
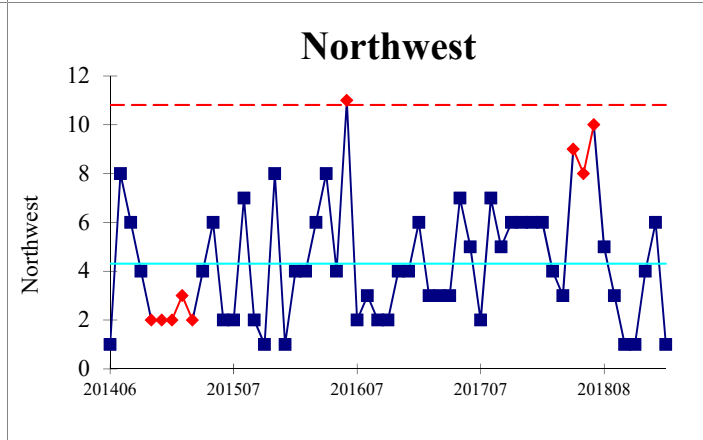
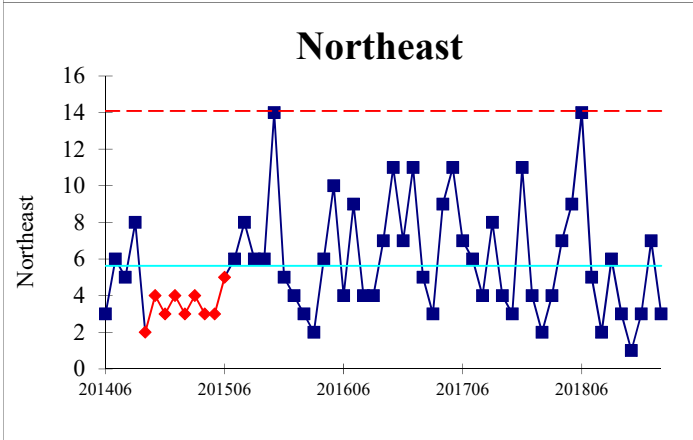
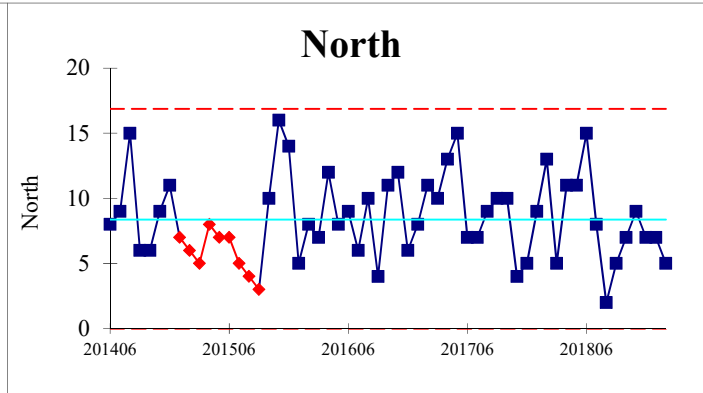
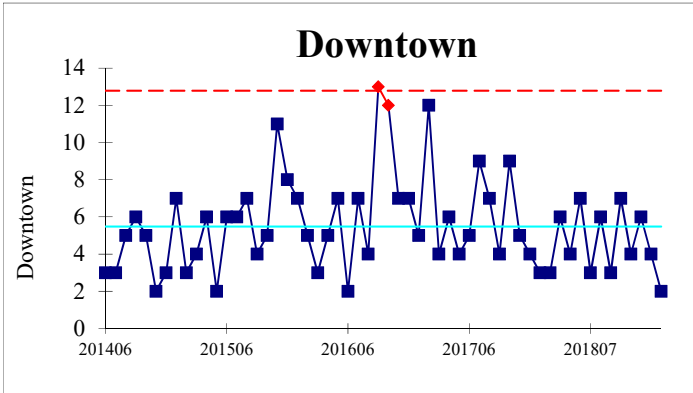


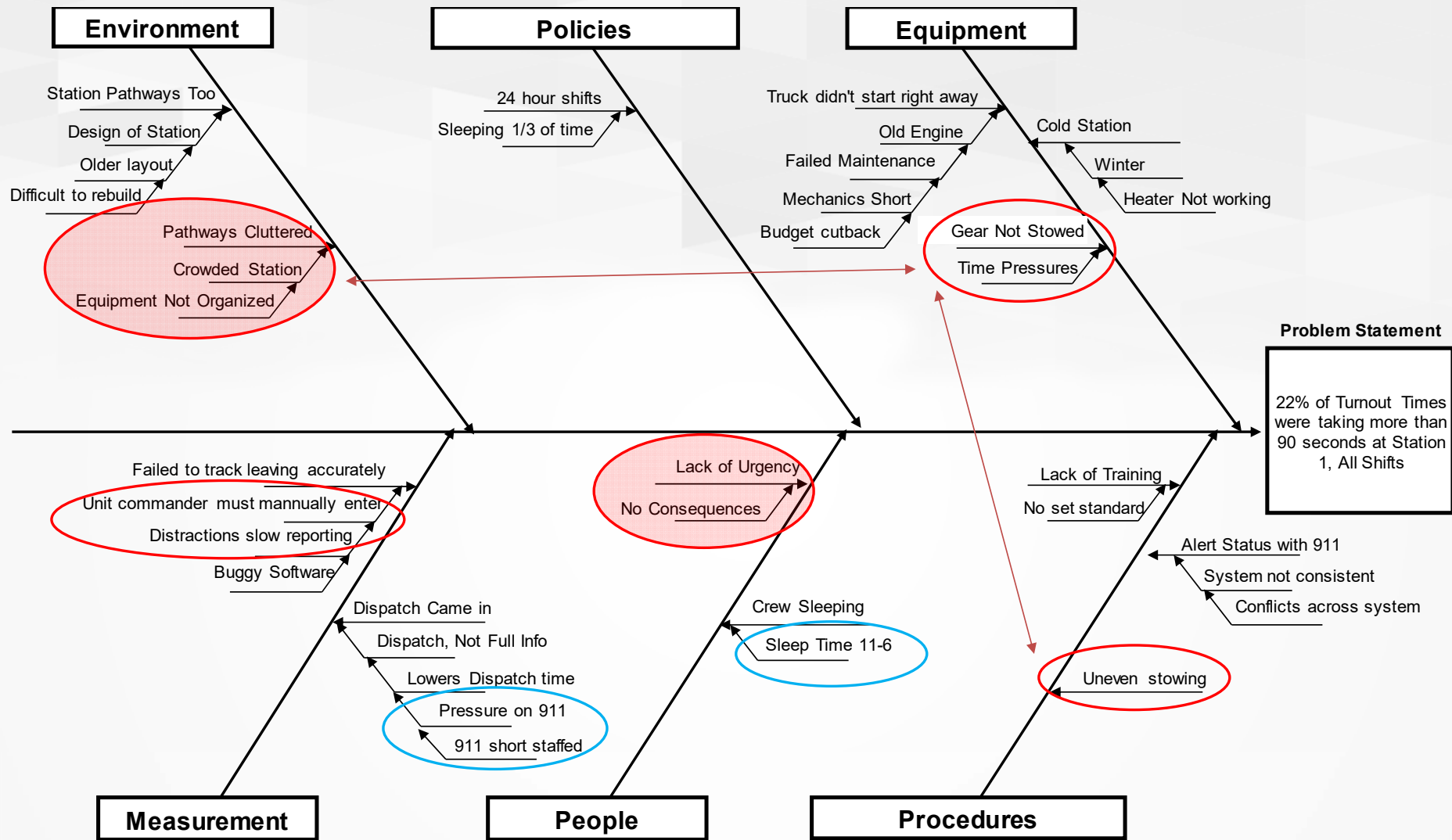
## mR TurnoutTimes



# Burglary/Commercial

Based on Raleigh Open NBIRS Data Reported by Month for June 2014 to February 20, 2019







# A CHECKLIST FOR CHECKLISTS

## DEVELOPMENT

- Do you have clear, concise objectives for your checklist?

### IS EACH ITEM:

- A critical safety step and in great danger of being missed?
- Not adequately checked by other mechanisms?
- Actionable, with a specific response required for each item?
- Designed to be read aloud as a verbal check?
- One that can be affected by the use of a checklist?

### HAVE YOU CONSIDERED:

- Adding items that will improve communication among team members?
- Involving all members of the team in the checklist creation process?

## DRAFTING

### DOES THE CHECKLIST:

- Utilize natural breaks in workflow (pause points)?
- Use simple sentence structure and basic language?
- Have a title that reflects its objectives?
- Have a simple, uncluttered, and logical format?
- Fit on one page?
- Minimize the use of color?

### IS THE FONT:

- Sans serif?
- Upper and lowercase text?
- Large enough to be read easily?
- Dark on a light background?
- Are there fewer than 10 items per pause point?
- Is the date of creation (or revision) clearly marked?

## VALIDATION

### HAVE YOU:

- Tried the checklist with front-line users (either in a real or simulated situation)?
- Modified the checklist in response to repeated trials?

### DOES THE CHECKLIST:

- Fit the flow of work?
- Detect errors at a time when they can still be corrected?
- Work easily enough that it can be completed in a reasonably brief period of time?
- Have a timetable for future review and revision of the checklist?

## Casual Labor Baseline Progress

