



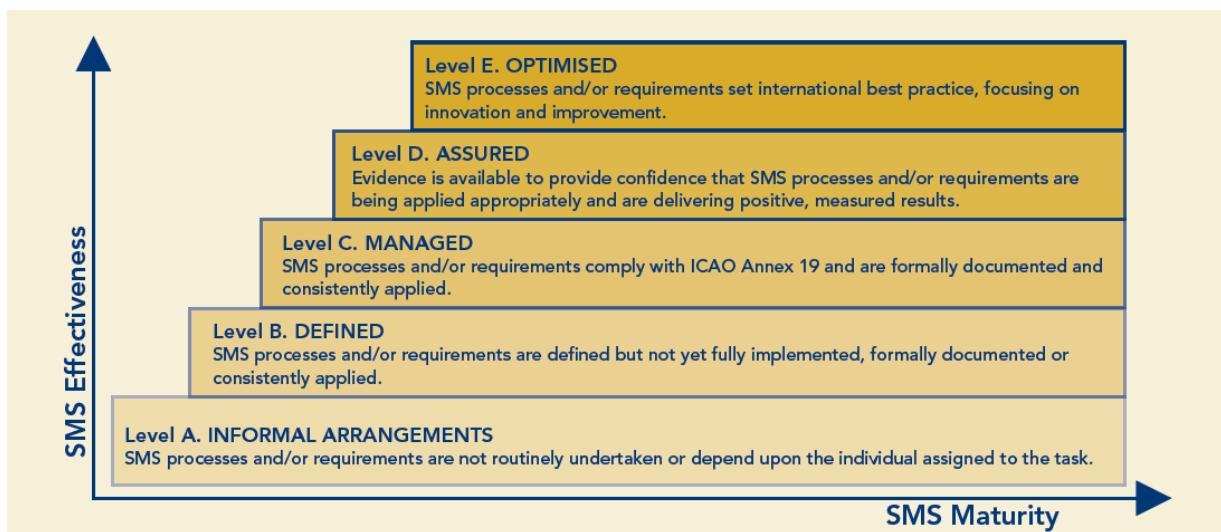
Safety Evolution Guide: Fatigue Risk Dashboard

1. OBJECTIVE OF GUIDE

Members of the Civil Air Navigation Services Organisation (CANSO) are committed to the improvement of their services. As part of this commitment, organisations share their practices in efforts transfer learning across the industry.

This guide captures:

- The practices of an Air Navigation Service Provider (ANSP) in one element of the CANSO Standard of Excellence (SoE) in Safety Management System (SMS). The practices of this ANSP have been recognized by their peers as being an optimised practice within the industry (see Figure 1). The optimized practices have been selected on the basis of their novelty, innovation or the recognition of their potential to manage operational risks.



Given the dynamic nature of safety management, the practices presented in this document may be superseded. CANSO will publish updated best practice guidance.

2. APPLICATION OF THE GUIDANCE

CANSO recognizes that this guidance will not be relevant to all ANSPs. The maturity of any ANSP's Safety Management System will be dependent on their specific context. This context will be a reflection of factors including the size and complexity of the organisation, domestic regulations and the risk appetite of the organisation.

ANSPs do not necessarily need to adopt all the practices and processes promoted by CANSO, but consider the relevance of the practices promoted in this guide to their operational environment.

3. OPTIMISED PRACTICE

This guide addresses a SMS process which was identified in 2020 as being optimised, it details how one Air Navigation Service Provider, NAV CANADA, developed and maintains a data-driven means of continuously monitoring and managing fatigue-related safety risks.

The approach was reviewed by a panel of experts from the NextGen SMS Workgroup of the CANSO Safety Standing Committee. The approach meets both the CANSO and International Civil Aviation Organisation's requirements for Fatigue-related Risk Management (see below).

4. SCOPE OF GUIDE

This guide aims to provide an insight into why and how NAV CANADA developed, implemented, and maintains a fatigue risk dashboard.

5. APPLICABLE STANDARDS AND REQUIREMENTS

This guide applies to one of the study areas in the CANSO Standard of Excellence in Safety Management Systems (2018) as shown below. [CANSO Standard of Excellence in Safety Management Systems.pdf \(icao.int\)](https://www.icao.int/safety-management-systems/Pages/default.aspx)

10. Fatigue-related Risk Management

Objective	Informal Arrangements	Defined	Managed	Assured	Optimised
10.1 A data-driven means of continuously monitoring and managing fatigue-related safety risk that aims to ensure relevant personnel are performing at adequate levels of alertness.	Fatigue-related risk is not recognised as a safety risk which needs to be managed.	Management considers fatigue to be an operational hazard/risk. The organisation has informal processes and procedures in place that address fatigue-related risk.	The organisation has formal processes and procedures by which fatigue is assessed and managed. The organisation has defined the responsibilities of management and employees for the management of fatigue-related risk. The organisation provides training on the management of fatigue-related risk.	The organisation continually assesses compliance with fatigue-related risk procedures. The organisation has processes to assess and improve the management of fatigue-related risk. The organisation uses data and information from internal and external sources to improve the management of fatigue-related risk.	The organisation has set best practice(s) for safety management for this objective and is willing to share those with other ANSPs/organisations.

6. OPERATIONAL AND ORGANISATIONAL CONTEXT

Managing fatigue is a shared responsibility between the company and its employees. The company must develop schedules and work plans that do not induce fatigue within the ANSP staff. ANSP staff must take measures to ensure sleep and rest are adequate to report for work fit for duty in a non-fatigued state. This reduces the risk of fatigue related human error in the delivery of air traffic services.

There are many factors that cause or contribute to a person 'feeling fatigued'. A dashboard was developed to help understand the Company's exposure to this risk based on the shift schedule and duty time rules developed through the company's Fatigue Safety Action Group (FSAG) using fatigue science criteria.

The application extracts the schedule information from NAV CANADA's Employee Scheduling System (ESS) on a daily basis, running it against the agreed fatigue rules

representing a proxy for actual sleep measures (the potential impact of the schedule in the quality and quantity of sleep opportunities).

It is important to highlight that there is never an inference to the level of 'tiredness' a particular individual, or of a group of people, may be experiencing; nor is the dashboard meant to be the sole source of data for evaluating exposure to fatigue. Rather, this tool allows the Company to monitor scheduling practices that could potentially lead an individual or ATS unit to experience fatigue, to identify facilities where a higher level of awareness is required, or to provide an impetus for further change to reduce fatigue risk.

Canada has not regulated fatigue duty limits for ATCOs within the Canadian Aviation Regulations as defined in ICAO Annex 11 and DOC 9966. However, NAV CANADA has developed its fatigue rules, policies, guides and manuals in accordance with ICAO Annex 11 and DOC 9966. NAV CANADA is managing its program in accordance with the FRMS components described within ICAO Annex 11 and DOC 9966.

7. FATIGUE DASHBOARD

7.1. FATIGUE SCIENCE

NAV CANADA uses four scientific factors to assess the risk of fatigue in schedules. These are:

- Acute Sleep Disruption
 - Rule 1: Rest is less than 12 hours
 - Rule 3: Night shifts, defined as a shift with any amount of time between 23:30 and 05:30
- Chronic Sleep Disruption
 - Rule 5: Time between non-consecutive shifts is less than 48 hours
 - Rule 6: More than 5 consecutive shifts worked and at least one night shift (see Rule 3)
 - Rule 7: Three or more consecutive night shifts
 - Rule 8: Two consecutive night shifts
- Continuous Wakefulness
 - Rule 2: Shift is longer than 12 hours
- Circadian Rhythm Disruption
 - Rule 4: Sum of hours of a shift and rest period is less than 21 hours
 - Rule 9: Backward shift rotation, defined as the latter shift starting three or more hours earlier than the start time of the previous shift
 - Rule 10: Duty-rest cycle exceeds 27 hours in block of consecutive shifts

7.2. OPERATIONAL METRICS

The following metrics are used to evaluate operational scheduling patterns:

- The number of consecutive shifts
- The shift duration
- The rest period duration between consecutive shifts
- The total hours worked within blocks of consecutive shifts
- The total days of rest between blocks of consecutive shifts.

7.3. FATIGUE RISK DASHBOARD - OVERVIEW

The dashboard was developed in Microsoft Power BI, pulling data from a number of sources, and is automatically refreshed daily.

The dashboard is used to provide regularly scheduled data driven updates for the General Managers in each FIR. Also, it is used as a basis for identification of potential fatigue trends which are briefed to the senior leadership within NAV CANADA at the recurring Steering Committee on Fatigue Management. The Fatigue Safety Action Group (FSAG) also uses the dashboard to analyse, comment and suggest future actions which to evolve fatigue management going forward.

Filtering dimensions include:

- Date
- Flight Information Region
- Facility Type (example: Tower, ACC, FSS, etc.)
- Facility Name (example: Toronto Tower, Vancouver Tower, etc.)
- ACC Specialty (example: Gander Oceanic, Toronto Terminal, etc.)
- Facility Hours of Operation (24 or non-24 hours)
- Fatigue science criteria

The primary metric used to benchmark performance when considering fatigue rules is the percentage of shifts that had at least one of the fatigue rules triggered ("Percentage of Shifts Affected"). The user can also select the minimum number of rules triggered per shift (e.g., only show the shifts that triggered at least 4 rules).

Unit benchmarking is also possible, where a certain unit (Facility Name or ACC Specialty) can compare their metrics against the national average, as well as facilities of the same type (e.g., select a tower, the average from other towers is displayed).

The operational metrics can be viewed as average, median, min, max, 25th and 75th percentile, standard deviation, as well as in histogram distributions.

The Fatigue Risk Dashboard presents the information in a variety of ways to inform local management as to the fatigue state of their units in this reactive process to inform

changes to schedules and practices in a proactive process. This display of information provides a one glance, ANSP wide overview of:

- Fatigue Heat Map all ATS Sites and specialities for schedule fatigue risk
- Fatigue Factors the four factors being measured and managed, Acute Sleep Disruption, Chronic Sleep Disruption, Circadian Rhythm Disruption and Continuous Wakefulness
- Fatigue Rule Trends what is trending for the 10 fatigue rules being tracked
- Summary Tables the percentage of shifts that are affected by each of the 10 fatigue rules to track exposure of fatigue risk
- Consecutive Shifts Summary of shifts linked back-to-back on the schedule
- Consecutive Shifts Comparison of shifts across all facilities by location and type of service delivered
- Shift Duration Length of shift by location, facility type and hours of operation
- Rest Duration Summary of median and average rest period across all facility types and locations
- Total Hours Worked Summary of average and total hours worked across all facility types and locations
- Total Days Rest Summary of number of days rest between blocks of shifts across all facility types and locations

8. SUMMARY

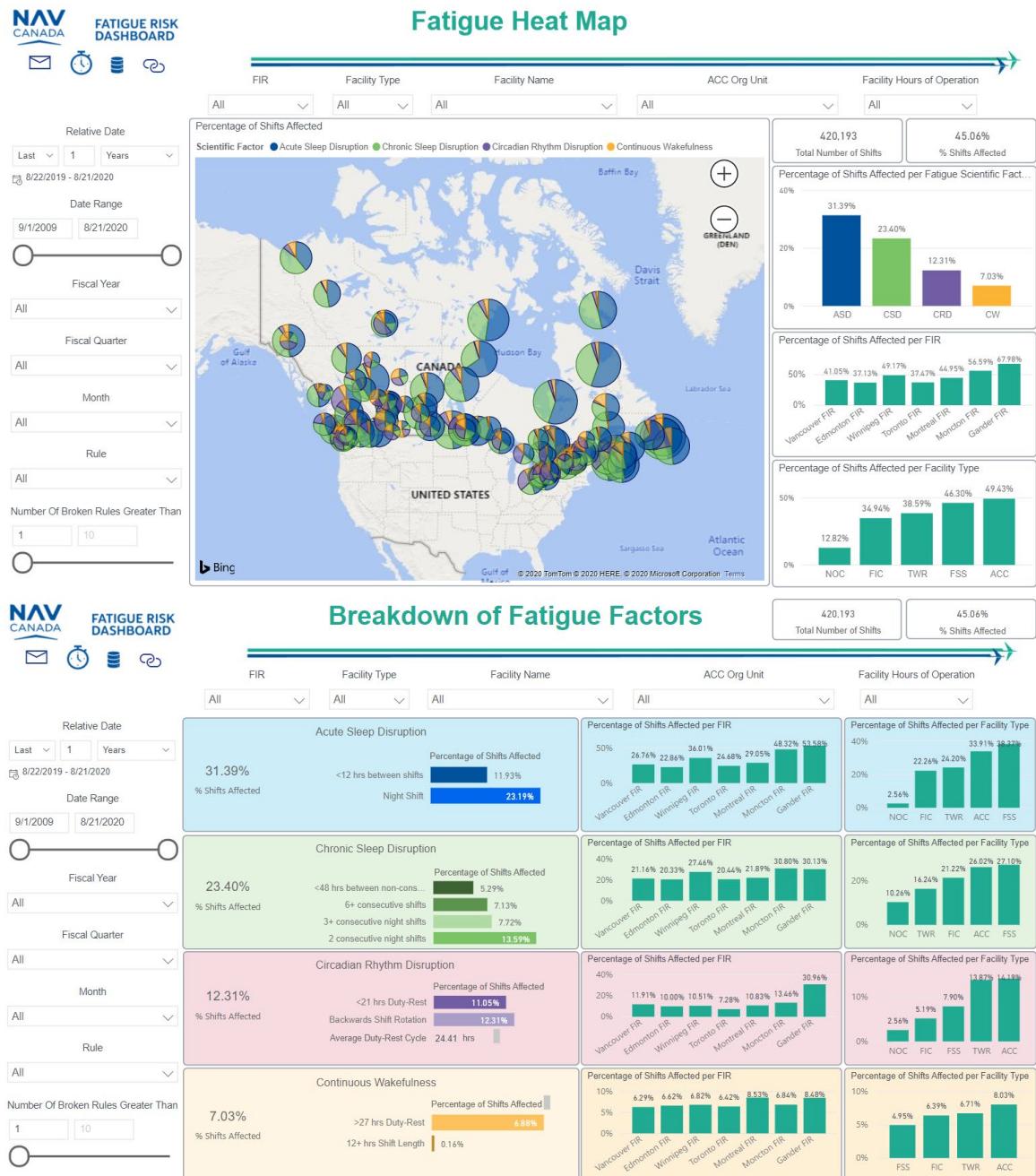
The practices in this guide present an example of how one ANSP has designed and implemented a fatigue risk dashboard. This data has informed fatigue management practices and procedures and is supported by a newly created Fatigue Policy and Standard with a Fatigue Manual in development.

9. APPENDICES

The following appendix is provided as additional guidance on the outputs of the fatigue dashboard:

- Appendix A – Fatigue Dashboard Example Screenshots

Appendix A – Fatigue Dashboard Example Screenshots





Fatigue Rule Trends

420,193
Total Number of Shifts

45.06%
% Shifts Affected



Summary Tables

420.193 Total Number of Shifts

45.06% % Shifts Affected

FIR Facility Type Facility Name ACC Org Unit Facility Hours of Operation

Relative Date: Last 1 Years 8/22/2019 - 8/21/2020

Date Range: 9/1/2009 - 8/21/2020

Fiscal Year: All

Fiscal Quarter: All

Month: All

Rule: All

Number Of Broken Rules Greater Than: 1 10

The percentage of shifts affected is calculated for each Facility/Specialty/FIR and therefore totals are not sums of parts.

Percentage of Shifts Affected by Each Rule (FIR > Facility Name)

FIR	1	2	3	4	5	6	7	8	9	10	Total
Vancouver FIR	10.33%	0.12%	19.43%	10.79%	5.35%	5.35%	7.42%	12.09%	11.91%	6.17%	41.05%
Edmonton FIR	8.55%	0.07%	16.79%	9.19%	5.49%	6.33%	7.19%	11.01%	10.00%	6.55%	37.13%
Winnipeg FIR	13.69%	0.28%	26.72%	9.50%	5.41%	8.78%	9.50%	16.61%	10.51%	6.56%	49.17%
Toronto FIR	6.70%	0.05%	18.67%	6.49%	6.42%	4.58%	6.65%	11.23%	7.28%	6.35%	37.47%
Montreal FIR	14.44%	0.33%	19.44%	9.57%	5.78%	7.39%	6.55%	11.35%	10.83%	8.21%	44.95%
Moncton FIR	12.99%	0.08%	40.10%	11.51%	3.39%	7.86%	14.12%	23.28%	13.46%	6.77%	56.59%
Gander FIR	24.35%	0.13%	39.13%	27.88%	3.14%	13.57%	5.87%	17.79%	30.96%	8.36%	67.98%
Total	11.93%	0.16%	23.19%	11.05%	5.29%	7.13%	7.72%	13.59%	12.31%	6.88%	45.06%

Percentage of Shifts Affected by Each Rule (ACC Org Unit)

ACC Org Unit	Total
Total	45.06%

To view ACC Org Units, please select a Centre of interest in the FIR > Facility table above or in the Slicer Pane

Consecutive Shifts

Summary

FIR **Facility Type** **Facility Name** **ACC Org Unit** **Facility Hours of Operation**

Relative Date: Last 1 Years (8/22/2019 - 8/21/2020)

Date Range: 9/1/2009 - 8/21/2020

Fiscal Year: All

Fiscal Quarter: All

Month: All

Max AVG

AVG - Number of Consecutive Shifts per FY, Q, M

Period	Avg Number of Consecutive Shifts
FY2019 Q-4	5.3
FY2020 Q-1	5.1
FY2020 Q-2	4.9
FY2020 Q-3	4.6
FY2020 Q-4	4.0

Total Number of Shifts

Value	Count
2	Min
55	Max
4.56	Average
2.11	Standard Deviation
4	Median
3	25th Percentile
5	75th Percentile
Percentage	Percentage

AVG - Number of Consecutive Shifts per Facility Name

Facility Name	Avg Number of Consecutive Shifts
KUUJUUAQ FSS	14.46
LA GRANDE FSS	13.79
RANKIN INLET FSS	9.77
IQALUIT FSS	8.02
PEACE RIVER FSS	6.02
INUVIK FSS	5.78
WILLIAMS LAKE FSS	5.66
NORMAN WELLS FSS	5.62
THOMPSON FSS	5.53
VICTORIA HARBOUR ...	5.51
BRANDON FSS	5.38
VAL-D'OR FSS	5.24

AVG - Number of Consecutive Shifts per ACC Org Unit

ACC Org Unit	Avg Number of Consecutive Shifts
Gander ACC-High	5.41
Gander ACC-Low	5.26
Vancouver ACC-East	5.14
Vancouver ACC-Airports	5.07
Edmonton ACC-Calgary Ter...	5.05
Winnipeg ACC-West High	5.03
Edmonton ACC-Edmonton E...	5.03
Gander ACC-ICAO	4.95
Montreal ACC-Terminal	4.89
Edmonton ACC-Arctic High	4.89
Edmonton ACC-North Low	4.88
Vancouver ACC-Vancouver H...	4.84
Vancouver ACC-TMU	4.82

Count of Total Consecutive Shifts

Facility Range	Count
2	14.3K
3	12.1K
4	17.7K
5	22.8K
6	9.9K
7	5.3K
8	2.6K
9	1.4K
10-14	1.1K
15-19	0.4K
20-24	0.1K
25-29	0.0K
30-34	0.0K
35-39	0.0K

Consecutive Shifts Comparison

Facility Type

Facility Name

ACC Org Unit

Facility Hours of Operation

Relative Date

Last 1 Years

8/22/2019 - 8/21/2020

Date Range

9/1/2009 8/21/2020

Fiscal Year

All

Fiscal Quarter

All

Month

All

Average Number of Shifts: ACC, TWR, FSS, FIC

Legend: ACC (Green), TWR (Grey), FSS (Yellow), FIC (Orange)

Period	ACC	TWR	FSS	FIC
FY2019 Q-4	5.0	4.8	5.0	5.2
FY2020 Q-1	4.8	4.7	4.9	4.9
FY2020 Q-2	4.7	4.6	4.8	4.7
FY2020 Q-3	4.4	4.4	4.4	4.4
FY2020 Q-4	4.3	4.3	4.3	4.4

6,536 Total Number of Shifts

2 Min	17 Max	4.80 Average
1.73 Standard Deviation	5 Median	
4 25th Percentile	5 75th Percentile	

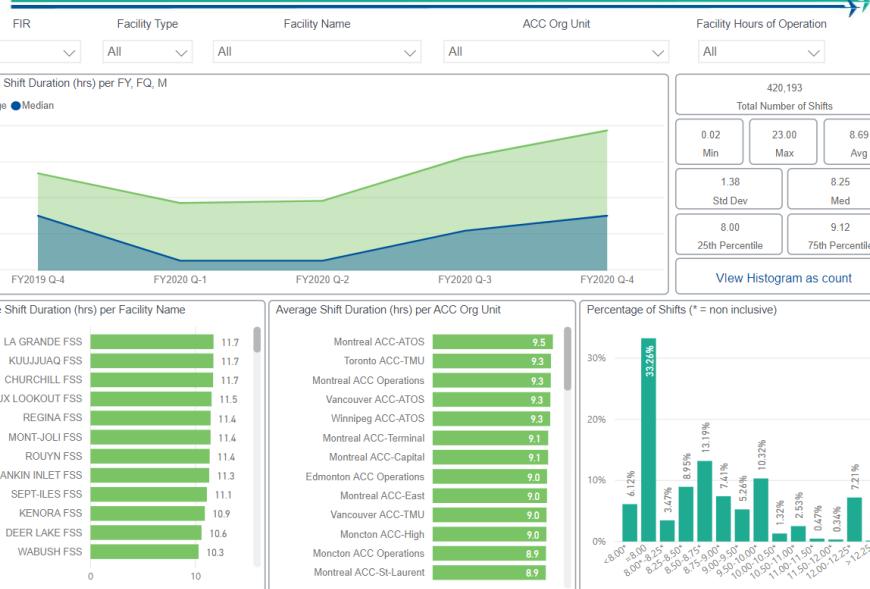
Averages Number of Shifts: National, Facility Type and Selection

Legend: National (Green), Selected Facility Name (Blue), Facilities of Same Type (Yellow)

Period	National	Selected Facility Name	Facilities of Same Type
FY2019 Q-4	5.2	5.5	5.0
FY2020 Q-1	5.0	5.3	4.9
FY2020 Q-2	4.8	4.9	4.8
FY2020 Q-3	4.4	4.8	4.4
FY2020 Q-4	3.9	4.5	4.1

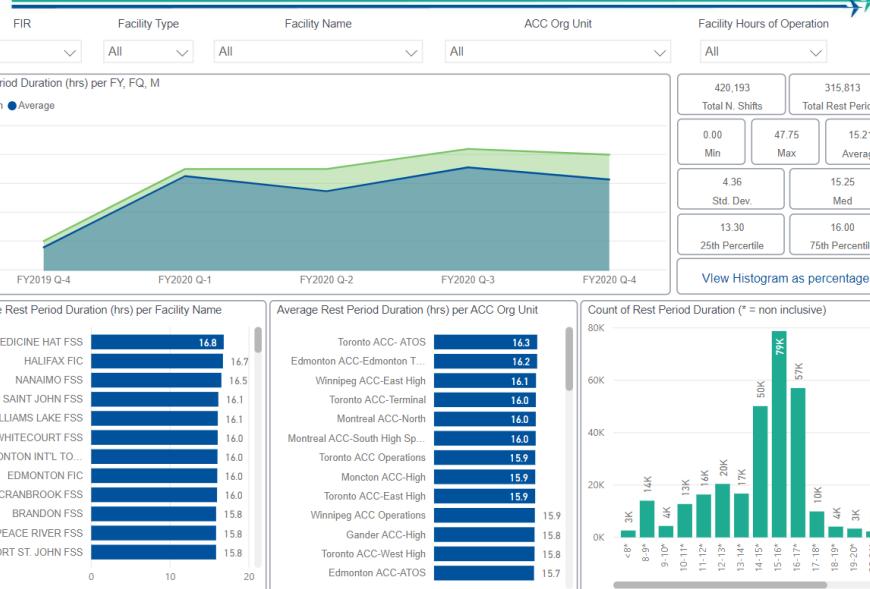
Shift Duration

Summary



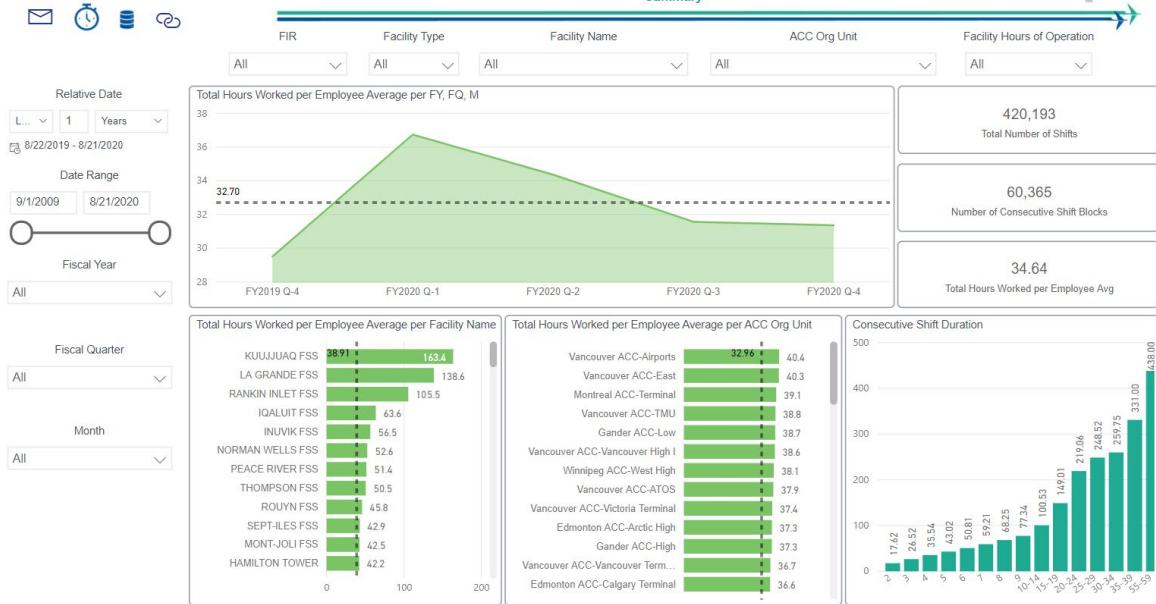
Rest Period Duration between Consecutive Shifts

Summary



Total Hours Worked within Blocks of Consecutive Shifts

Summary



Total Days of Rest between Blocks of Consecutive Shifts

Summary

