Transport Canada Transports Canada

REPORT OF THE CANADIAN AVIATION REGULATION ADVISORY COUNCIL (CARAC) FLIGHT CREW FATIGUE MANAGEMENT WORKING GROUP

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Section 1 Introduction

1.1 Background

In 2010 the Canadian Aviation Regulation Advisory Council (CARAC) Technical Committee struck a working group to review and propose amendments to the Canadian Aviation Regulations (CARs) relating to the management of flight crew fatigue. The Working Group had three main objectives:

1. To review the existing Flight Time and Duty Time Limitations and Rest Periods (FDT&RP) regulatory scheme pertaining to flight crew with reference to and utilising current scientific data relating to fatigue.

2. To review the basic principles of the fatigue risk management system approach to fatigue management as it would apply to flight crew with reference to and utilising current scientific data relating to fatigue.

3. To determine the commonalities and differences with respect to the FDT & RP and Fatigue Risk Management Systems (FRMS) approach to the management of fatigue in order to develop recommendations for regulatory proposals which might include:

    a) identifying and analysing differences that consider the current Canadian operational environment and;
    b) suggesting alternate recommendations in respect to, for example, fatigue and the operational environment.

The Working Group convened 14 times between August 2010 and December 2011. In accordance with the Terms of Reference (TOR) for the Working Group, the Working Group primarily focused its deliberations around available and defensible scientific data. In addition, the Working Group considered the work already completed by Transport Canada in regards to FRMS, as well as the regulations and proposals of the International Civil Aviation Organization (ICAO) and other States in an effort to adopt and harmonize regulations and best practices with those States, where appropriate. The Working Group also considered operational experience.

The decision to form a Working Group was influenced by the publication of a revised Standard and Recommended Practice (SARP) by the ICAO. ICAO recommended that States review their existing flight and duty time regulations to determine if they meet the revised SARP and are based on current science. Additionally, the ICAO introduced a SARP for fatigue management systems as a complimentary method of managing flight crew fatigue.

To the extent possible, this report reflects the outcomes of the Working Group's discussions in respect to the review of the existing CARs and the ICAO SARP.

1.2 Principles

Intrinsic to this Working Group Report is the principle that fatigue affects all flight crew. As such, the Working Group Chairs were given direction from the Canadian Aviation Regulatory Committee (CARC) that, to the extent possible, the proposals should apply to all flight crew members and air operators.

Additionally, the co-chairs respected the principle that harmonization should be achieved wherever possible.

The Working Group co-chairs acknowledge that the European Aviation Safety Agency (EASA) and the Federal Aviation Administration (FAA) revised regulatory proposals only apply to large air carriers.

1.3 Decision-Making Methodology

This is not a unanimous Working Group report; consensus was not gained on all the recommendations contained herein. In accordance with the TOR, dissents will be appended directly to the report and submitted to the CARAC Technical Committee and forwarded on to the CARC for consideration. Please see Appendix 7 for a record of dissents.

The Report respects the principal established in the TOR that "the Working Group will base its work on scientific data that is defensible and readily available. In addition, the Working Group will consider the work already completed by Transport Canada in regards to FRMS, as well as the regulations and proposals of ICAO and other States in an effort to adopt and harmonize regulations and best practices with those States, where appropriate."

The Report was developed in keeping with the CARAC Charter's position on situations were consensus is not achievable: "Where consensus on a proposal cannot be reached, all views must be properly recorded so as to allow the Working Group Leader to make recommendations to the Technical Committee on those issues. Recommendations may be to adopt any one of the expressed views, propose an alternative solution or defer the decision to the Technical Committee based on the information provided. In all cases, the recommendations should then be reviewed and discussed by the Working Group to ensure they reflect the group's intent, and any agreed changes that should be incorporated. Dissenting views must be included with the recommendations in the report".[1]

Respecting this principal, the co-Chairs used the scientific data available to assess the Working Group member's positions put forward during the meetings and in submissions made following the final meeting. Please see Appendix 6 for the submissions. The positions of Working Group members who did not make submissions may be found in

[1] CARAC Management Charter and Procedures 4th edition, 2008

the meeting records. All positions / submissions were analyzed in depth to ensure that they respected the science available to the Working Group. Where consensus was achieved the recommendation was accepted. Where consensus was not achieved, the co-Chairs used the science first, then harmonization and finally the operational experience of working group members to develop a recommendation.

1.4 Report Structure

The report is organized into sections that describe the issue, the recommendation and a reference to the science that supports the recommendation. Each section references whether the recommendation is harmonized with other regulatory authorities and whether operational experience was used to justify the requirement. There is a reference to any existing regulation and a summary of the Working Group Members position on the issue.

Example 1:

> **Issue**: *Nutrition*
>
> **Recommendation:** *When a FDP exceeds 6 hours, the air operator shall provide the flight crew member with a food and drink opportunity every 6 hours.*
>
> **Science:** *Research has shown that inadequate nutrition can have a negative impact on an individual's alertness levels. An explanation of the importance of proper nutrition is contained in Chapter 5 of TP14573 – Fatigue Management Strategies for Employees.*
>
> **Harmonization:** *The current EASA OPS 1.1130 contains a requirement for a meal and drink opportunity to be provided. The EASA NPA 2010-014 amplifies this current requirement.*
>
> **Existing Regulation:** N/A
>
> **Summary of Positions**: Unanimous agreement

It is useful to note that, as per the Working Group's agreement, operational experience was divided into three categories and weighted accordingly:

> Operational experience based on scientific data derived from a controlled setting;
> Operational experience derived from a company database, survey or collective opinion of multiple flight crew;
> Operational experience based on the opinion of one or two people.

The science used was available to all Working Group members and is referenced in Appendix 2. The report format respects the deliverables as per the Working Group TOR.

1.5 Working Group Membership

Working Group membership was determined by the CARAC Technical Committee and comprised the following members:

1. Air Canada Pilots Association (ACPA) – First Officer Doug Tweedlie
2. Airline Pilots Association (ALPA) – Captain Martin Gauthier
3. Air Transport Association Canada (ATAC) - Bill Boucher
4. Helicopter Association of Canada (HAC) – Fred Jones
5. Manitoba Aviation Council (MAC) - Dennis Lyons
6. National Airlines Council of Canada (NACC) – Captain Michel Chiasson
7. Northern Air Transport Association (NATA) – Stephen Nourse
8. Canadian Business Aircraft Association (CBAA) – Art Laflamme (replaced in 2011 by Merlin Preuss)
9. Teamsters (Canada) – Phil Benson
10. Transport Canada Civil Aviation (TCCA) – Mark Laurence
11. West Jet Pilots Association (WJPA) – Captain Daniel Glass

In addition to the eleven Working Group members, there were also numerous technical advisors and observers in attendance at all of the meetings.

1.6 Meetings

The Working Group met 14 times over the course of a year and a half. The meetings were designed to address the scope of the Working Group's activities as defined by the TOR. The following list highlights how the requirements of the TOR were met and the topic of discussion:

Meeting number and date	Subject Matter	Presenter
1, August 25th, 2010	CARs, FARs, ICAO SARP, EASA comparative analysis	Mark Laurence, (TCCA) Dale E. Roberts, (FAA)
2, September 20-21, 2010	FAA ARC WG FRMS	Captain Don Wykoff Delta, Captain Jim Mangie (Delta), Dale Roberts (FAA) Bill Cox, (CASA Australia) Dr David Powell, Air New Zealand
3, November 3-4, 2010	Lifting the Fog of Fatigue	Dr Gregory Belenky (WSU)

	Bio-mathematical Models Regulatory Comparison	Dr Karen Robertson (QinetiQ) Emma Romig (Boeing) Len Pearson (Interdynamics FAID) Mark Laurence (TCCA)
4, December 7-8, 2010	Definitions	Working Group members
5, January 10-11, 2011	Review of EASA NPA and adoption of template	Working Group members
6, February 17-18, 2011	Discussion: maximum duty day, Reduction due to WOCL intrusion, start of WOCL, sectors, Planned extensions, FDP cumulative limits, rest periods. Teleconference with Dr Belenky	Working Group members Dr Gregory Belenky (WSU)
7, March 9-10, 2011	Discussion of letter from HAC and validation of science Report of 705/704 sub group and 703/702 sub group, helicopter sub-group Discussion of other provisions Creation of sub groups	Fred Jones (HAC) Mark Laurence (TCCA) Rob Freeman (TCCA) Working group members Jacqueline Booth
8, April 19-21, 2011	Discussion of written questions submitted to Dr Belenky in March, 2011 and teleconference with Dr.Belenky. Comments on other scientific papers Discussion of common elements as defined by Fred Jones Review of sub-group structure Debrief of sub groups Review of FDP/WOCL Reduction grids and minimum Rest periods, time zones and nutrition, operator	Working group members Dr Gregory Belenky (WSU) Dr Gregory Belenky (WSU) Fred Jones (HAC) Martin Gauthier (ALPA) Working group members

	responsibilities.	
9, May 18-20th, 2011	Review of definitions Fatigue management plans, flight crew member responsibilities, record keeping, FDP, duty period limits, split duty. Rest period. Fatigue management training. Disruptive schedule proposal Extended FDP, sectors, standby, time zones, unforeseen operational circumstances.	Working Group members Martin Gauthier (ALPA) Doug Tweedlie (ACPA) Working Group members
10, June 20-22, 2011	Medevac discussion NACC/ALPA proposal time zones Shift transitions early-late-early etc. Standby scenario review. Suitable accommodation. Augmentation, airport standby, positioning, split duty, disruptive schedules. Discussion of joint submission to co-chairs from ATAC, HAC, NATA, CBAA, MAC	Working Group members Fred Jones (HAC)
11, September 27-29, 2011	Discussion of CARC decision in respect to the Association's June letter. Prescriptive fatigue management plan, FDP, FDP sector reductions, crew rest facilities, FDP extensions due to in flight rest, Unforeseen circumstances in actual flight (PIC's discretion, short term planning), FDP limits, positioning, split duty, standby, rest periods and time free from duty,	Jacqueline Booth Working Group members

12, October 27th, 2011	Flight time and duty limitations, split-duty, discussion on 604 demographic, discussion of proposal from MAC, briefing on helicopter sub group, planned extensions, unforeseen circumstances	Working Group members
13, November 23-25, 2011	Rest at hotel, HAC helicopter proposal for flight duty times, Duty day, cumulative flight time, time free from duty, unforeseen operational circumstances, split duty, WOCL table for IFR, Extensions, Minimum rest, consecutive night duty, parking lot issues, final report and CARAC, definitions, air operator responsibilities, flight crew member responsibilities, prescriptive fatigue management documentation, nutrition, records,	WG members Fred Jones (HAC) WG members
14, December 12-16, 2011	Cumulative duty hours, discussion of CAR 702/703 proposal, considerations for the final report, table 1 flight duty periods, standby, discussion of ALPA max FDP table, extensions, Teleconference with Dr Belenky, Discussion of HAC proposal, standby, FDP, day free from duty, definitions, schedule reliability,	WG members Stephen Nourse, NATA ALPA Dr Belenky Fed Jones, HAC

	disruptive schedules, minimum days off, NATA / ATAC / CBAA 604 702/703 proposal fixed wing operations, non-EMS (Medivac) Operations, Ultra long range operations, time free from duty, airport standby, discussion on Bombardier's new aircraft, NACC proposal, WJPA table proposal, additional questions for Dr Belenky, FRMS	NATA / ATAC / CBAA WG members NACC, Michel Chiasson WJPA, Dan Glass WG members

1.7 Scientific Advisor

The Working Group TOR speaks to the appointment of a scientific advisor. At the first Working Group meeting (August 25th 2010) it was agreed that the requirements for the scientific advisor should include:

Specific aviation experience
Be able to provide an overview of the current literature on sleep, fatigue, alertness specific to aviation
Have an operational understanding of fatigue in aviation

Additionally the advisor should have knowledge of:

Circadian shift, Time zones and related issues.
Correlation of time of day and accidents
Crew rest facilities
Effect of daylight/lack of daylight/extended daylight on fatigue and performance
Experience in utilising FRMS concepts

It was determined during meeting 1 that the basic role of the scientific advisor was to be available to discuss the aforementioned issues. A list of seven scientists was nominated and a series of questions developed and approved for use during the interview process. Dr Greg Belenky was chosen as the scientific advisor for the group. His resume is detailed in Appendix 4.

1.8 Summary

The attached Working Group Report was developed in conjunction with the Working Group Members. While it does not always reflect a consensus position, to the extent possible, it does respect the overriding principles established in the TOR: science, harmonization and operational experience.

Section 2 Recommendations

This Section contains recommendations in respect to prescriptive flight, duty and rest periods and related regulatory provisions. In addition, Section 2 also contains recommendations for fatigue risk management requirements. For each recommendation the issue is described, the recommendation detailed, the Working Group's position stated and where available, the science, harmonization and existing regulatory requirement described.

It should be noted that while these provisions are intended for all operators, only those requirements that apply to the operations conducted under the AOC apply and would need to be documented. For example, Ultra Long haul operations are conducted by CAR 705 AOC holders only. Likewise, standby provisions are not required if the operator chooses not to have a standby system.

2.0 Definitions

The definitions section provides clarity through an interpretation of the terms utilised in this document.

Airport standby means standby when a flight crew member is required by the operator to be at a designated location, usually at an aerodrome.

Acclimatized means the physiological and mental state of a crew member whose bio-rhythms and bodily functions are considered aligned with local time.

Acclimatized time means the time at the location where the flight crew member is acclimatized.

Augmented flight crew means a flight crew which comprises more than the minimum number required to operate the aircraft allowing each flight crew member to leave their assigned post and be replaced by another appropriately qualified flight crew member for the purpose of in-flight rest.

Break means a period of time on the ground, shorter than a rest period, when the flight crew is free of all duties but still considered to be within a flight duty period.

Consecutive FDPs refers to FDP assignments occurring on consecutive days, when the flight crew member has only the required rest period between the FDP assignments.

Consecutive days free from duty means a single day free from duty followed by a further 24 hours free from duty for each additional consecutive day.

Crew member means a flight, technical or cabin crew member.

Duty means any task that a flight crew member is assigned by an air operator at a specific time, including flight duty, administrative work, training, positioning, and standby.

Duty period means a period which starts when a flight crew member is required by an operator to report for or to commence a duty and ends when that person is free from all duties.

Early Duty means a flight duty period that starts between 02:00 – 06:59, in the flight crew member's acclimatized time.

Fatigue means a physiological state of reduced mental or physical performance capability resulting from sleep loss or extended wakefulness and/or physical activity that can impair a crew member's alertness and ability to safely operate an aircraft or perform safety related duties.

Fit for duty means that the crew member is not suffering from fatigue or likely to suffer from fatigue, under the influence of alcohol or drugs, or mentally or physically impaired in any way that would impair their ability to safely operate an aircraft or perform safety related duties for the duration of the planned flight duty period.

Flight crew member means a crew member assigned to act as pilot or flight engineer of an aircraft during flight time.

Flight duty period (FDP) means a period that begins when a flight crew member is required to report for duty with the intention of conducting a flight, a series of flights, or positioning, and ends when the aircraft is parked with “engines off” or “rotors stopped” after the last flight and there is no intention for further aircraft movement by the same flight crew member.

FDP table start time means the local time at the flight crew member’s designated home base or at the location where the flight crew member is acclimatized during a FDP and is the time of day used to determine the maximum permitted FDP from the FDP Table.

Flight time means the time from the moment an aircraft first moves for the purpose of taking off until the moment it finally comes to rest at the end of the flight;

Home base means the location nominated by the operator to the crew member from where the crew member normally starts and ends a duty period or a series of duty periods and where, under normal circumstances, the operator is not responsible for the accommodation of the crew member concerned.

In flight rest facility means a bunk, seat, room, or other accommodation that provides a flight crew member with a sleep opportunity:

1. Class 1 rest facility means a bunk that meets the Society of Automotive Engineers (SAE) *Aerospace Recommended Practice (ARP) 4101/3, Crew Rest Facilities*, used in conjunction with *ARP 4101, Flight Deck Layout and Facilities*. (If ARP changes, new aircraft must meet new standard. Old aircraft grandfathered. Date of registration in Canada used as reference.)

2. Class 2 rest facility means a seat in an aircraft cabin that allows for a flat or near flat and horizontal sleeping position, which is separated from passengers at least by a curtain to provide darkness and some sound mitigation, equipped with portable oxygen and is reasonably free from disturbance by passengers or crew members;

3. Class 3 rest facility means a seat in an aircraft cabin or flight deck that reclines at least 40 degrees from vertical, provides leg and foot support and is not attached or joined to any seat occupied by passengers.

Late duty means a FDP finishing in the period between 00:00 and 01:59 hours, in the flight crew member's acclimatized time.

Local night's rest means when the flight crew member's rest period fully encompasses the hours between 22:30 to 07:30 in the local time zone (able to report for duty at 07:30)

Night duty means a FDP that starts between 13:01 – 01:59 and finishes after 02:00, in the flight crew member's acclimatized time.

Positioning means the transferring of a flight crew member from one place to another, at the request of the operator, excluding both the time from home to the designated reporting place at home base and vice versa, and the time for local transfer from a place of rest to the commencement of duty and vice versa.

Prescriptive fatigue management documentation means a set of flight and duty time limitations including flight time, flight duty period, duty period limitations and rest period requirements and the policies and procedures for their application.

Rest period means a continuous and defined period of time, subsequent to and/or prior to duty, during which a flight crew member is free of all duties.

Sector means a single flight that includes one takeoff and landing - synonymous with leg or flight segment.

Single day free from duty means a time free of all duties consisting of a single day and two local night's rest and which may include a rest period as part of the single day free from duty.

Split duty means a duty period where the FDP is extended by one or more breaks on the ground within the FDP.

Standby means when a crew member is required by the operator to be available to receive an assignment for a specific duty without an intervening rest period.

Standby availability period (SAP) means a defined period of time during which a crew member is on standby.

Standby accommodation means a place that protects from the elements, a place to sit, where available not open to the public, and with access to food and drink.

Standby duty period (SDP) means the elapsed time from the beginning of the SAP to the end of an assigned FDP without an intervening rest period.

Suitable accommodation means, for the purpose of standby, split duty and minimum rest, a single-occupancy bedroom that is subject to a minimal level of noise, with sufficient ventilation and the ability to regulate temperature to a comfortable sleeping temperature and light intensity or, where such a bedroom is not available, accommodation that is suitable for the site and season, is subject to a minimal level of noise and provides adequate comfort, to obtain horizontal rest, and protection from the elements;

Ultra long range operations (ULR) means long range flights having a planned flight time greater than 16 hours or a flight duty period that exceeds 18 hours;

Unforeseen operational circumstances means an unplanned event such as un-forecast adverse weather, equipment malfunction or air traffic delay, which is beyond the control of the operator and that the flight crew member becomes aware of after leaving home or the suitable accommodation.

Window of circadian low (WOCL) means the period between 02:00 and 05:59 hours in the time zone to which the flight crew member is acclimatised.

3.0 Air Operator Responsibilities

The following define the responsibilities of all air operators in respect to the management of fatigue. The purpose in stating these responsibilities is for clarity. To avoid confusion, ambiguity, and to ensure a full understanding of the obligations related to the management of fatigue.

Recommendation: An air operator shall establish processes to (where applicable to the type of operation):

- publish duty schedules sufficiently in advance to provide the opportunity for flight crew members to plan adequate rest;
- ensure that flight duty periods are planned in order to enable flight crew members to remain sufficiently free from fatigue;
- specify reporting times to allow sufficient time for duties;
- take into account the relationship between the frequencies and pattern of flight duty periods and rest periods and give consideration to the cumulative effects of undertaking long duty hours combined with minimum rest periods;
- allocate duty schedules which avoid practices that cause a serious disruption of established sleep/work pattern such as alternating day/night duties;
- provide rest periods of sufficient time to enable flight crew members to overcome the effects of the previous duties and to be fit for duty by the start of the following flight duty period;
- plan days free of duty and notify flight crew members sufficiently in advance;
- ensure that flights are planned to be completed within the allowable flight duty period taking into account the time necessary for pre-flight duties, the flight and turn-around times as well as any changes to the schedule while on duty that may impact the number of sectors flown during that duty period;
- collect actual flight time / flight duty time data necessary to support the planning of flight operations;
    - change a schedule or crewing arrangements when: the planning for a given FDP or flight time is found to be unrealistic the operator must make the adjustment within 28 days following the discovery.
    - report adjustments made to comply with schedule reliability to TC every two months.
    - use all available data to plan realistic flight times and flight duty periods.

Note 1: Planning is considered unrealistic when the maximum FDP or flight time is exceeded on more than 10% of the time using a sampling of 10 events or 56 days; the operator may choose which sampling.

- require that flight crew members declare to the air operator whether or not they are fit for duty, prior to beginning a flight duty period.
- not assign a flight crew member, who has declared them self not fit for duty, to a flight duty period;

- remove a flight crew member who is no longer fit for duty from a flight duty period assignment.
- include flight times and duty times accumulated in other flight operations, flight training units, and military aircraft when calculating individual flight crew member flight time and flight duty period limitations. Document all procedures and processes related to the flight, duty, rest and all related provisions.

Science: N/A

Harmonization: EASA and the FAA have clearly defined obligations for the air operator in respect to the management of fatigue.

Operational Experience: The present CARs define some air operator obligations. As such most air operators have experience in developing and documenting their obligations under the CARs.

Existing Regulations: CARs

Summary of Positions: The Working Group had general agreement on the air operator responsibilities.

4.0 Flight Crew Member Responsibilities

The following define the responsibilities of flight crew members in respect to the management of fatigue. The purpose in stating these responsibilities is for clarity. To avoid confusion, ambiguity, and to ensure a full understanding of the flight crew responsibilities related to the management of fatigue.

Recommendation: A flight crew member shall:

- plan to use the rest periods provided by the air operator to obtain sleep to recover from a previous flight duty period and to be fit for duty in order to safely perform their duties during a subsequent flight duty period;
- prior to beginning a flight duty period, declare to the air operator whether or not they are fit for duty;
- not begin a flight duty period if they are unfit for duty;
- as soon as possible and as applicable, advise the air operator, the pilot-in-command, and other flight crew members, if during a flight duty period, they become unfit for duty; and,
- report to the air operator all flight time and duty times accumulated in operations for other air operators, flight training units, and military aircraft for calculation of flight time and flight duty period limitations.

Science: N/A

Harmonization: N/A.

Operational Experience: N/A.

Existing Regulations: CARs (fitness for duty)

Summary of Positions: The Working Group had general agreement on the flight crew member responsibilities.

5.0 Prescriptive Fatigue Management Documentation

This section is a list of policies and procedures that the air operator is expected to document in their operations manual for the management of flight crew fatigue.

Recommendation: An air operator shall document the policies, procedures and processes required for compliance with the applicable prescriptive limitations.

An air operator shall nominate a home base for each flight crew member.

With respect to Flight Duty Period (FDP) the air operator shall have processes:

- specifying how the pilot-in-command shall — in case of special circumstances which could lead to fatigue, and after consultation with the crew members affected — reduce the actual FDP and/or increase the rest period in order to eliminate any detrimental effect on flight safety.

- specifying how the pilot-in-command shall — in case of unforeseen operational circumstances which could lead to fatigue, and after consultation with the crew members affected, increase the actual FDP in order to manage any detrimental effect on flight safety.

- requiring the pilot-in-command to submit a report whenever an FDP is increased beyond the maximum or decreased at his/her discretion, in actual operations.

- for reviewing all increases beyond the maximum FDP to determine the percentage of FDPs that increase beyond the maximum FDP.

- for adjusting the schedule where any FDP that is shown to actually increase beyond the maximum FDP more than 10 percent of occasions.

- for notifying the Minister of an FDP that exceeds the maximum FDP by more than 1 hour and provide the review and analysis of the increase as soon as practicable.

- for providing food and drink opportunities for flight crew members.

The air operator shall document how the operator intends to meet the requirements, where applicable, with respect to the following FDP elements:

- Maximum basic daily FDP;
- Reductions of the maximum basic daily FDP dependent on the number of sectors flown;
- Reductions of the maximum basic daily FDP when this FDP would start, end or encompass the WOCL;

Science: N/A

Harmonization: Documentation requirements are integral to the FAA and EASA regulations.

Operational Experience: The present CARs require appropriate documentation.

Existing Regulations: CARs

Summary of Positions: There was consensus on this issue.

6.0 Nutrition - Providing the Flight Crew Member with Food and Drink Opportunities

This section deals with the requirement to provide adequate opportunity for food and drink throughout a duty period.

Recommendation: When a FDP exceeds 6 hours, the air operator shall provide the flight crew member with food and drink opportunity every 6 hours. The timing of the food and drink opportunities should be scheduled at appropriate intervals.

Science: Research has shown that inadequate nutrition can have a negative impact on an individual's alertness levels. An explanation of the importance of proper nutrition is contained in Chapter 5 of TP14573 – Fatigue Management Strategies for Employees. Dr. Belenky emphasized the importance nutrition plays along with exercise and sleep in maintaining a person's health and performance.[2]

Harmonization: The current EASA OPS 1.1130 contains a requirement for a meal and drink opportunity to be provided. The EASA Comment Response Document (CRD) to NPA 2010-014 amplifies this current requirement.

Operational Experience: N/A

Existing Regulation: N/A

Summary of Positions: Unanimous agreement

[2] Flight Crew Fatigue Management Working Group (FCFMWG), *RDIMS-#6554697-v1-Dr. Greg Belenky Report To Fatigue Management Working Group*, page 4.

7.0 Records of Flight and Duty Times and Rest Periods

This section deals with the requirement to maintain records related to flight duty, duty, and rest periods.

Recommendation: Air operators shall maintain:

- Individual records of flight, duty and rest period for all crew members, for a period of 24 months, including:
    - Flight times;
    - Start, duration and end of each duty and FDP;
    - Rest periods and days free of all duties;
- Reports by the pilot-in-command on extended flight duty periods and extended flight hours, for a period of 24 months.
- Upon request the air operator shall provide a flight crew member with copies of their individual records of flight and duty times and rest periods.

Science: N/A

Harmonization: While not strictly a harmonization issue, all regulatory authorities require that records be maintained. This enables the authority to verify compliance with the requirements by the air operator and permits the air operator to manage their operation within the bounds of the requirements.

Operational Experience: The proposal reflects the current CAR requirements with one addition. When requested by the flight crew member, the air operator shall provide copies of the individual's records to the flight crew member. This proposal enables the flight crew member to provide records of their flight, duty, and rest periods to a second air operator: and records from the second air operator to the first. Thus all flight, duty, and rest periods can be considered by air operators and flight crew members when scheduling and accepting flight duty.

Existing Regulation: 700.14 (1).

Summary of Positions: Unanimous agreement

8.0 Flight Duty Period (FDP)

This section deals with the duration of the flight duty period and provides fatigue mitigations based on the time of day and the number of sectors flown.

Recommendation: The working group could not reach consensus on the maximum FDP duration. The science suggests a maximum FDP of 12 hours would be effective in managing flight crew fatigue. A maximum FDP of 12 hours provides sufficient time to obtain rest, limits performance degradation over the course of the FDP, and provides adequate time for nutrition, hydration, hygiene, and social requirements. It should be noted that mental health suffers when there is insufficient time to deal with these issues. Poor mental health has been linked to inability to sleep and poor physical health in general.

Table 1 reflects a compromise position recommended by the Co-Chairs. It considers multiple aspects of the science of fatigue and provides operational flexibility while also considering harmonization with other authorities.

Instructions for using Table 1:

- Determine the start time of the FDP and determine the acclimatized time of the flight crew member; if these are the same, enter the Table in the row containing the local start time of the FDP. Otherwise see section 26.0 Determining FDP Table Start Time.
- Determine the planned number of sectors and the average sector flight time; using the row with the appropriate average sector flight time, locate the appropriate column for the number of sectors;
- The maximum FDP will be at the intersection of the Start FDP row and Number of Sectors column.
- When the air operator wishes to introduce schedule changes (additional sectors or reductions in sectors) during a FDP, the air operator has two options:
    - if the changes do not result in an increase to the originally planned FDP duration the original FDP limit remains unchanged; or
    - if the changes result in an increase to the originally planned FDP duration, adjust the FDP limit using Table 1 taking into account the new number of sectors flown. Any change in the average sector time as a result of the change in schedule will not be used to further reduce the length of the FDP.
- Non-scheduled VFR helicopter operations always use Column A of the Table.

Table 1 - Maximum Daily FDP						
		Columns				
		A	B	C	D	E
Average Sector Flight Time		Number of Sectors				
> 50 minutes		1-3	4	5	6	7+
30 to 50 minutes		1-5	6-7	8-9	10-11	12+
< 30 minutes		1-8	9-11	12-14	15-17	18+
Rows	Start of FDP	Maximum FDP (hours)				
1	0700-1259	13.0	12.5	12.0	11.5	11.0
2	1300-1459	12.5	12.0	11.5	11.0	10.5
3	1500-1659	12.0	11.5	11.0	10.5	10.0
4	1700-1859	11.5	11.0	10.5	10.0	9.5
5	1900-2059	11.0	10.5	10.0	9.5	9.0
6	2100-2259	10.5	10.0	9.5	9.0	9.0
7	2300-0429	10.0	9.5	9.0	9.0	9.0
8	0430-0459	10.5	10.0	9.5	9.0	9.0
9	0500-0529	11.0	10.5	10.0	9.5	9.0
10	0530-0559	11.5	11.0	10.5	10.0	9.5
11	0600-0629	12.0	11.5	11.0	10.5	10.0
12	0630-0659	12.5	12.0	11.5	11.0	10.5

The following sections (8.1-8.3) provide the scientific basis for the recommendations relating to Table 1 in respect to the length of duty day, infringements to the WOCL and FDP reductions based on the number of sectors flown.

8.1 Science: Length of Basic FDP

The length of time that a person is continuously awake is the principal determinant of human performance, not time on duty.[3] Dr. Belenky was asked if there is a scientific argument-based average flight duty period, recognizing that the flight crewmember has had an adequate opportunity for rest prior to reporting, and whether the science points to a 13 hour FDP being better than 14 hour FDP with appropriate rest following the FDP.

Dr. Belenky responded that "the correct way to argue this is to work backwards from total sleep time. To sustain performance over the long-haul people need 7-8 hours of actual sleep in each successive 24-hour period…. …To determine the desirable duty period one adds the 7-8 hours' sleep time to the commuting, eating, etc. time and subtracts it from 24 hours. Thus, taking 8 hours of sleep and 4 hours for commuting, eating, etc., the calculated duty period would be 12 hours. It is not so much the length of the duty period as the need to provide 7-8 hours of actual sleep time/24 hours that should guide the discussion of duty period. [4]

Human performance will begin to degrade after being awake for between 12 and 14 hours. This degradation in performance has been demonstrated in laboratory studies and in analyzing incident and injury rates.[4 -16, 19, 20]

Studies have shown that after being awake for 17 hours performance is degraded to a level equivalent to having a blood alcohol concentration of 0.05% and after 24 hours performance is degraded to a level equivalent to having a blood alcohol concentration of 0.10%.

[3] Dawson D, McCulloch K., *Managing Fatigue – It's about sleep*, Sleep Medicine Reviews, Vol. 9, pages 365-380, 2005.
[4] FCFMWG, *Questions and Answers on the Fog of Fatigue - Belenky*, page 2.

Correlation between cognitive performance with sleep deprivation and ethanol intoxication[5,6,7,8]	
Sleep deprivation (hours)	Functional serum ethanol level (%)
17 - 19	0.05
19 - 21	0.08
24	0.10

Research has shown that fatigue increases as shifts increase in length, with associated increases in accident likelihood. Studies have found a transient increase in risk after 2-4 hours[9] with much larger increases observed after 9-10 hours[10, 11] and 12 hours[12] on shift. A near two-fold increase in likelihood of incident or accident has been found following 10 hours compared to 8 hours on shift[13]. A three-fold increase in accident likelihood has been found to occur after 16 hours[14]. A study from the United States found that working at least 12 hours per day was associated with a 37% increased hazard rate.[15]

Other research from the United States found a pattern of deteriorating performance on psycho physiological tests as well as injuries while working long hours was observed

[5] Clark S., *Sleep deprivation: implications for obstetric practice in the United States***,** American Journal of Obstetrics & Gynecology, 2009; 201:136.e1-4.
[6] Arendt JT, Owens J, Crouch M, et al., *Neurobehavioral performance of residents after heavy night call vs. after alcohol ingestion*, Journal of the American Medical Association, 7 September 2005, Vol. 294, No. 9 1025-1033
[7] Dawson D., Reid K., *Fatigue, alcohol and performance impairment*, Nature, 17 July 1997, Vol 388, 235-237.
[8] Williamson AM, Feyer AM., *Moderate sleep deprivation produces impairment in cognitive and motor performance equivalent to legally prescribed levels of alcohol intoxication***.** Occupational and Environmental Medicine, 15 June 2000. Vol. 57, 649-655
[9] Folkard S, *Black times: temporal determinants of transport safety*, Accident Analysis and Prevention, 1997, Vol. 29. No. 4. 417-430.
[10] Folkard S, Tucker P, *Shift work, safety and productivity*, Occupational Medicine**,** 01 February 2003, Vol. 53, No. 2, 95-101.
[11] Rosa R, *Extended workshifts and excessive fatigue*, Journal for Sleep Research, December 1995, Vol. 4, s2, 51-56.
[12] Folkard S, *Black times: temporal determinants of transport safety*, Accident Analysis and Prevention, 1997, Vol. 29. No. 4. 417-430.
[13] Folkard S, Tucker P, *Shift work, safety and productivity*, Occupational Medicine**,** 01 February 2003, Vol. 53, No. 2, 95-101.
[14] Rosa R, *Extended workshifts and excessive fatigue*, Journal for Sleep Research, December 1995, Vol. 4, s2, 51-56.
[15] Dembe A, Erickson J, Delbos R, Banks S, *The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States*, Occupational and Environmental Medicine, 08 March 2005, Vol. 62, 588-597.

across study findings, particularly with very long shifts and when 12-hour shifts combined with more than 40 hours of work a week. Four studies that focused on effects during extended shifts reported that the 9th to 12th hours of work were associated with feelings of decreased alertness and increased fatigue, lower cognitive function, declines in vigilance on task measures, and increased injuries. Two studies examining physicians who worked very long shifts reported deterioration on various measures of cognitive performance.[16]

An aviation specific report found that the proportion of accidents associated with pilots having longer duty periods is higher than the proportion of longer duty periods for all pilots. “For 10–12 hours of duty time, the proportion of accident pilots with this length of duty period is 1.7 times as large as for all pilots. For pilots with 13 or more hours of duty, the proportion of accident pilot duty periods is over 5.5 times as high. Twenty percent (20%) of human factor accidents occurred to pilots who had been on duty for 10 or more hours, but only 10% of pilot duty hours occurred during that time. Similarly, 5% of human factor accidents occurred to pilots who had been on duty for 13 or more hours, where only 1% of pilot duty hours occur during that time. There is a discernible pattern of increased probability of an accident the greater the hours of duty time for pilots”.[17]

From the 1996 National Aeronautics and Space Administration (NASA) Technical Memorandum “to reduce vulnerability to performance-impairing fatigue from extended hours of continuous wakefulness and prolonged periods of continuous performance requirements, cumulative flight duty per 24 hours should be limited. It is recommended that for standard operations, this cumulative flight duty period not exceed **10 hours within a 24-hour period**. Standard operations include multiple flight segments and day or night flying.”[18]

And for “Extended flight duty period- An extended cumulative flight duty period should be limited to **12 hours within a 24-hour period** to be accompanied by additional restrictions and compensatory off-duty periods. This limit is based on scientific findings from a variety of sources, including data from aviation, that demonstrate a significantly increased vulnerability for performance-impairing fatigue after 12 hours. It is readily acknowledged that in current practice, flight duty periods extend to 14 hours in regular operations. However, the available scientific data support a guideline different from current operational practice. The data indicate that performance impairing fatigue does increase beyond the 12-hour limit and could reduce the safety margin.”[19]

[16] Caruso C, Hitchcock E, Dick R, Russo J, Schmit J, *Overtime and Extended Work Shifts: Recent Findings on Illnesses, Injuries, and Health Behaviors*, U. S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, April 2004.
[17] Goode J, *Are pilots at risk of accidents due to fatigue?* Journal of Safety Research, 27 March 2003.
[18] Dinges D, Graeber C, Rosekind M, Samel A, Wegmann H, *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation*, NASA Technical Memorandum 110404, May 1996, page 6.
[19] ibid, page 6.

From the 1997 Samel study, “During day-time, fatigue-dependant vigilance decreases with task duration, and fatigue becomes critical after 12 hours of constant work. During night hours fatigue increases faster with ongoing duty. This leads to the conclusion that 10 hours of work should be the maximum for night flying.”[20]

From the 1998 *An Overview of the Scientific Literature Concerning Fatigue, Sleep, and Circadian Cycle*, “This increased likelihood of accident risk due to long duty periods has been found in other studies. The relative risk of an accident at 14 hours of duty rises to 2.5 times that of the lowest point in the first eight hours of duty. Askertedt (1995) reports accident risks to be threefold at 16 hours of duty, while Harris and Mackie (1972) found a threefold risk in just over 10 hours of driving. These levels of risk are similar to that associated with having narcolepsy or sleep apnea (Lavie et al., 1982), or a blood alcohol level of 0.10 percent. Wegmann et al. (1985), in a study of air carrier pilots, argued for a duty period of 10 hours with 8.5 hours or less of flight duty period.[21]

Dr. Belenky was asked for his recommendation for the maximum FDP assuming a good night’s rest. Based on his experience, for unaugmented crews, beginning a FDP around 08:00, and a single take-off and landing (not multiple sectors), the maximum FDP should be12-13 hours.[22] This assumes that the flight crew member is waking up at 06:00 or later.[23]

As described above, and verified by Dr. Belenky, the scientific evidence supports a maximum FDP 10 hours during the night and 12 hours during the day:

“The 12 hour day and 10 hour night un-augmented limits are good. I would add to the night limit the stipulation that the flight schedule not include critical phases of flight (take offs, landings) between 0300 and 0800 as that is roughly the most degraded period of operational performance from the perspective of the circadian rhythm”.[24]

Harmonization: EASA – the current EU OPS 1.1105 sets a maximum 13 hour FDP. The EASA CRD to NPA 2010-014 maintains the 13 hour maximum FDP.

The FAA Final Rule sets a maximum 14 hour FDP, however this is combined with a maximum 9 hour flight time limitation during the 14 hour FDP[25].

[20] Samel A, Wegmann H, Vejvoda M, *Air Crew Fatigue In Long-Haul Operations*,, Accident Analysis and Prevention, 1997, Vol. 29, No. 4, page 451.
[21] Battelle Memorial institute (for the Federal Aviation Administration), *An Overview of the Scientific Literature Concerning Fatigue, Sleep, and Circadian Cycle*, 13 March 1998, page 13.
[22] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 Dec 2012, page 11.
[23] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 Dec 2012, page 5.
[24] FCFMWG, *Responses to Questions for Belenky Nov 2011 RDIMS-#7101240-v1-Questions For SME, Flight Crew Fatigue Management Working Group***,** page 1.
[25] In Subparts 705 & 704 of the CARs, this is equivalent to a flight duty time of 14.25 hours.

Both EASA and the FAA allow the maximum FDP to be available beginning at 06:00. According to Dr Belenky "the vulnerability to performance impairment from truncated sleep combined with being in the window of circadian performance low would be greatest between 06:00am to 09:00am and again in the mid to late afternoon."[26]

Operational Experience: The current CAR sets a maximum FDP of 14 hours. The current CAR also includes 15 minutes for post flight duties (704 & 705) within the FDP. This is different from both the EASA and the FAA. If the current CAR definition were maintained, we would require a 13 hour 15 minute FDP to equal the EASA 13 hour FDP for 704 & 705.

Existing Regulation: 700.16 (1)

Summary of Positions: The working group was divided on the maximum value for the maximum flight duty period. There was consensus that the length of the FDP should be reduced where it infringed on the window of circadian low (WOCL – 02:00 to 05:59). The working group developed a table to be used in determining the length of the FDP based on the start time of the FDP – similar to the EASA NPA and FAA NPRM. The 24 hour day was divided into 12 start time windows of varying lengths. There was consensus on these start time windows. There was also consensus on the notion of reducing the FDP based on workload (i.e.: reductions for sectors flown for aeroplanes). Consensus could not be reached on the value for the maximum FDP. The working group was also divided on the subject of the definition of FDP and should the FDP continue to include 15 minutes for post flight duties.

8.2 Science: FDP Reduction For WOCL Infringement

Human performance is degraded during the WOCL. The only sure method of avoiding this period of degraded performance would be to not operate aircraft during the WOCL. That would not be a practical solution for civil aviation. Dr. Belenky made the recommendation to avoid critical phases of flight during the WOCL (i.e., takeoff, approach and landing) [21]. This may be something that could be considered when scheduling.

It is not always practical to avoid critical phases of flight during the WOCL. As such, the working group agreed that a more feasible mitigation would be to reduce the length of the FDP. Reducing the duration of the FDP that infringes on the WOCL should reduce the acute fatigue and the flight crew member should be better able to remain alert during the WOCL.

Two studies looked at overnight operations and reached the conclusion that the duty period should be restricted to no more than 10 hours through the night. This was due to

[26] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group*, 13 Dec 2012, page 5.

the fact that flight crews working through the night showed performance degradation expressed in slower response times and increased sleepiness. [27,28]

Dr. Belenky raised the issue of ensuring that flight crews are properly rested and the importance, whenever possible, of not truncating the flight crew member's sleep prior to a maximum duration FDP (i.e.: the flight crew member is not required to wake up during the WOCL (prior to 06:00) which would prevent a full night's rest). [29]

Harmonization: EASA – the current EU OPS 1.1105 reduces the maximum 13 hour FDP by up to 2 hours for WOCL infringement. The EASA CRD to NPA 2010-014 maintains the 2 hour reduction for WOCL infringement.

The FAA Final Rule reduces the maximum 14 hour FDP by up to 5 hours for WOCL infringement. It should be mentioned that the FAA and EASA have an FDP of 13 hours at 0600, further the FAA has 14 hours at 0700 and EASA has proposed 14 with a planned extension for balance.

Operational Experience: N/A.

Existing Regulation: N/A

Summary of Positions: All members supported the concept of a 3 hour reduction to the maximum FDP based on WOCL infringement. The Working Group was divided on the time of day that the maximum FDP would be available and value of the maximum FDP. Proposals ranged between the maximum FDP value being available between the hours of 06:00, 07:00, or 07:30 to 12:59 for a 13 hour maximum FDP and 06:00 or 07:00 to 11:59 for a 14 hour maximum FDP.

8.3 Science: FDP Reduction For Sectors Flown

There have been several studies conducted that have found that fatigue increased with the number of sectors flown. One study found that the increase from one to a 4-sector duty was equivalent to the effect of an additional 2.77 hours duty or approximately 55

[27] Samel A, Wegmann H, Vejvoda M. Drescher J, Grundel A, Manzev D, Wenzel J, *Two-crew operations: stress and fatigue during long-haul night flights*, Aviation, Space, and Environmental Medicine, August 1997, Vol. 68, 679-687.
[28] Spencer M, Robertson K, *The Haj operation: alertness of aircrew on return flights between Indonesia and Saudi Arabia*, Defence Evaluation and Research Agency, June 1999.
[29] FCFMWG, *Responses to Questions for Belenky Nov 2011 RDIMS-#7101240-v1-Questions For SME, Flight Crew Fatigue Management Working Group*, page 1.

minutes duty per sector.[30] Three other studies found that the most important influences on fatigue were the number of sectors and duty length.[31,32,33]

Harmonization: EASA – the current EU OPS 1.1105 reduces the maximum 13 hour FDP by up to 2 hours for sectors flown. Reductions begin with the third sector flown. The EASA CRD to NPA 2010-014 maintains the 2 hour reduction for sectors flown beginning with the third sector.

The FAA Final Rule reduces the maximum 14 hour FDP by up to 2.5 hours for sectors flown. Reductions begin with the third sector flown.

Operational Experience: N/A

Existing Regulation: N/A

Summary of Positions: The working group was divided on the application of reductions to the FDP based on sectors flown. There was initial consensus on the concept. There were differing opinions on when the reductions should begin: after the 2nd, 3rd, 4th, 5th or 6th sector. The representatives of the 702 and 703 sectors completely opposed to the concept. Concerns were raised about the applicability of the research as it was conducted in airline category aeroplanes. Consensus was reached on a proposal to tie sector reductions to average sector duration: the shorter duration of the average sector, the more sectors allowed prior to a reduction in FDP.

Scheduled or medevac rotary wing operations conducted under CAR 703 & 704 will be subject to the reductions to FDP due to sectors flown. No other rotary wing operations conducted under CAR 702, 703 & 704 will be subject to reductions to FDP due to sectors flown.

[30] Spencer M, Robertson K, *Aircrew alertness during short-haul operations including the impact of early starts*, QinetiQ, February 2002.
[31] Powell D, Spencer M, Holland D, Broadbent E, Petrie K, *Pilot fatigue in short-haul operations: effects of number of sectors, duty length, and time of day*. Aviation, Space and Environmental Medicine, July 2007, Vol. 78, No. 7, 698–701.
[32] Bourgeois-Bougrine S, Cabon P, Gounelle C, Mollard R, Coblentz A, *Perceived fatigue for short- and long-haul flights: a survey of 739 airline pilots*. Aviation, Space and Environmental Medicine, October 2003, Vol. 74, No. 10, 1072–1077.
[33] Powell D, Spencer M, Holland D, Broadbent E, Petrie K, *Fatigue in Two-Pilot Operations: Implications for Flight and Duty Time Limitations*, Aviation, Space, and Environmental Medicine, November 2008, Vol. 79, No. 11, 1047-1050.

9.0 Planned Extensions to the Daily FDP

This section deals with planned extensions to the maximum flight duty period and the conditions under which they should be permitted. This relates to flights operated by the minimum number of flight crew whose FDP is not extended through us of inflight rest or split duty.

Recommendation: There is no science supporting the use of extensions without the use of split duty or augmented flight crews. It is not recommended, therefore that planned extensions, that do not include split duty or augmented flight crews, be allowed as part of a prescriptive flight and duty time regime. Under approved criteria, they may be acceptable as part of an implemented and approved fatigue risk management system.

Science: If the science referred to in footnotes 3 to 24 & 27 to 33 is used a basis for a limitation, then exceeding that limitation is not justified. Dr. Belenky holds the belief that once you have established the limitation then that should be the limitation. [34] Allowing the limitation to be increased to 14 hours would result in performance degradation. [35]

Dr. Alex Gundel, in his comments on the EASA NPA, states: "Extensions seem to be a questionable and strange element in FTL regulations. Safety concerns do not allow increasing the basic maximum FDP but these concerns are not expressed with regular extensions. Furthermore, the extension of FDP by 1 hour during night is certainly less safe than during daytime." [36]

Mick Spencer, also in his comments to EASA states: "Therefore an extension of one hour should not be permitted in any circumstances for duties starting between 18:00 and 21:59, or for duties starting between 22:00 and 03:59 which, contrary to the statement in the NPA (paragraph 89), are also at a critical time. This is without prejudice to the recommendation that the use of extensions to the basic FDP table proposed in the NPA should not be permitted outside the period 08:00 to 12:00." [37]

The Moebus Report found: "The provisions of EU OPS for the maximum basic FDP of 13 hours (extending up to 14 hours) are not in keeping with the body of scientific evidence."[38]

Harmonization: The EASA CRD to NPA 2010-014 permits a 1 hour extension to the FDP with reductions for sectors. There are times of day when the extension is not permitted due to WOCL infringement. The FAA final rule does not permit extensions.

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[34] FCFMWG, *Meeting 8 RDIMS - 6717755 April 2011*, page 15.
[35] FCFMWG, *Meeting 7 RDIMS - 6648143 March 2011*, page 19.
[36] EASA**,** *Comment Response Document to NPA 2010-14A*, 18 January 2012, page 144.
[37] EASA**,** *Comment Response Document to NPA 2010-14A*, 18 January 2012, page 171.
[38] EASA / Moebus Aviation, *Final Report "Scientific and Medical Evaluation of Flight Time Limitations"***,** 30 September 2008, page 15.

Operational Experience: The Canadian experience with planned extensions is limited to augmented flight crews and split duty.

Existing Regulation: N/A

Summary of Positions: The working group discussed the concept of permitting planned extensions to the basic FDP. There was no agreement on the issue.

10.0 Extension of FDP Due To In-Flight Rest

This section details the criteria under which extensions to flight duty periods are permitted as a result of in flight rest.

Recommendation: On aircraft equipped with in flight rest facilities, the maximum FDP value as per the FDP table may be increased by:

- with one additional flight crew member:
    - Class 3 rest facility: + 1.5 hours / maximum FDP 14.0 hours
    - Class 2 rest facility: + 2.5 hours / maximum FDP 15.0 hours
    - Class 1 rest facility: + 3.5 hours / maximum FDP 15.0 hours
- With two additional flight crew members:
    - Class 3 rest facility: + 3.0 hours / maximum FDP 15.25 hours
    - Class 2 rest facility: + 4.25 hours / maximum FDP 16.5 hours
    - Class 1 rest facility: + 7.0 hours / maximum FDP 18.0 hours

Under the following conditions:

- The augmented FDP shall be limited to 3 sectors.
- The minimum opportunity for in-flight rest period shall be:
    - for flights planned as 1 sector, a balanced or optimized division of duty and rest between all of the flight crew members; or,
    - for flights planned as 2 or 3 sectors:
        - a period of 2 consecutive hours for the flight crew members seated at the aircraft controls for the final landing; and
        - a period of consecutive 90 minutes for all other flight crew members.
- All flight crew members shall commence their FDP at the same reporting place if they are part of an augmented crew. However, if the first sector of the FDP is planned at a flight time of less than 105 minutes, the augmenting flight crew member may join the flight following the first sector (join for the second sector).
- At least one augmenting flight crew member shall be on the flight deck during all takeoffs and landings.

- In order to determine the maximum time available for in flight rest, the air operator shall use the phase of flight between climbing above 10,000 above aerodrome elevation and 15 minutes prior to the planned beginning of the descent.

- All the time spent in the rest facility shall be counted as FDP.

- The minimum rest following an augmented flight shall be at least as long as the preceding duty period or at least 14 hours in the suitable accommodation or 16 hours at home base, whichever is the greater (other provisions may also apply to the length of the rest period – time zone differences).

- Where a flight crew is augmented by the addition of at least one flight crew member, the total flight time accumulated during the flight shall be logged by all flight crew members for the purposes of calculating the maximum flight times.

- An in flight rest facility shall be provided for each augmenting flight crew member.

Science: The report prepared by Simons and Spencer, *Extension of flying duty period by in-flight relief* is the scientific standard concerning inflight rest. A brief summary of the recommendations follows:

For the fully acclimatized individual, and based on the bunk/seat classification given above, allow the following extensions to the maximum permitted FDP.

- Bunk or class I seat: a period of time equivalent to 75% of the duration of the rest period.
- Class II seat: a period of time equivalent to 56% of the rest period.
- Class III seat: a period of time equivalent to 25% of the rest period.
- Class IV seat: no extension.

The maximum FDP permitted under these regulations should be limited to 18 h. If augmentation is only by one additional pilot, the maximum FDP should be 16 h.[39]

Harmonization: Most jurisdictions base extensions due to inflight rest on the type of rest facility provided and whether the flight crew is augmented with one or two additional flight crew members – highest class of rest facility with two augmenting flight crew members permits the longest extensions.

[39] Simons M, Spencer M, *Extension of flying duty period by in-flight relief*, Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, TNO-DV 2007 C362, September 2007, page 20.

Comparison table of TNO, EASA, and FAA

Class of Rest Facility	Extension Value (hours)							
	Single Augmentation				Double Augmentation			
	TNO	EASA*	FAA**		TNO	EASA*	FAA**	
Class 1	3:00	3:00	3:00		5:00	4:00	5:00	
Class 2	2:15	2:00	2:30		3:50	3:00	4:00	
Class 3	0:55	1:00	1:00		1:35	2:00	1:30	

* EASA – The extension values may be increased by 1 hour for flights that include a single sector over 9 hours continuous flight time and a maximum of 2 sectors.

** FAA – Increase to maximum available FDP (flight time limit of 13 hours).

Operational Experience: The current CARs allow for extensions with augmented flight crews and inflight rest: with one additional flight crew member; 3 hours with a flight relief facility (seat) and 6 hours with a flight relief facility (bunk).

Existing Regulation: 720.16 (3)

Summary of Positions: The working group members affected by this provision agreed to the definitions, conditions for the use of extensions due to inflight rest and augmented flight crews, and values for the extensions.

11.0 Unaugmented Long Range Flights

This section describes additional restrictions to flight duty periods and sectors available associated with unaugmented long range flights.

Recommendation: For flights operated by un-augmented flight crews:

- When a FDP includes a sector with a planned flight time greater than 10 hours the maximum FDP in the table is reduced by 1 hour.

- When a FDP infringes on the crewmember's WOCL and includes a sector with a planned flight time greater than 7 hours, no additional sector can be operated after the long-range sector.

- An additional sector may be operated after the long-range sector, provided the operation is conducted as part of an approved fatigue risk management system.

Science: There was limited science presented concerning this issue.

Harmonization: Most authorities set a single sector flight time limitation.

Neither the current EU OPS or CRD to NPA 2010-014 include a limitation on single sector long range flights.

The FAA Final Rule includes a 9 or 8 hour maximum daily flight time limitation for un-augmented flights.

Operational Experience: The CARs currently attempt to manage this through increased rest requirements and sector limitations following a transoceanic flight.

Existing Regulation: 700.22

Summary of Positions: There was consensus on the idea of a reduction to the FDP for single sector long range flights, however consensus was not reached on the value of the reduction.

12.0 Ultra Long Range Flights

This section defines the requirements under which ultra long range operations may be conducted.

Recommendation: The ULR operations shall only be conducted as part of an approved fatigue risk management system.

Science: ULR operations have been studied at great length and they require active management to be successfully and safely conducted. An approved fatigue risk management system is the accepted method to achieve this.

Harmonization: The international standard is to require a fatigue risk management system for the conduct of ULR operations.

Operational Experience: Limited. The CARs permit augmented flight duty periods up to 20 hours in duration.

Existing Regulations: 700.22 & 720.16

Summary of Positions: There was consensus on this issue.

13.0 Unforeseen Operational Circumstances — Pilot-In-Command's Discretion

This section defines the criteria by which extensions due to unforeseen operational circumstances may be permitted. Unforeseen operational circumstances occur due to events such as weather, aircraft serviceability and air traffic control delays and may require extensions to the maximum FDP.

Recommendation: The conditions for the modification of the limits on flight duty, duty and rest periods by the pilot-in-command in the case of unforeseen operational circumstances, shall comply with the following:

- The maximum daily FDP may be increased as follows:
    - For single pilot operations, by not more than 1 hour;
    - For un-augmented flight crews, by not more than 2 hours;
    - For augmented flight crews with a FDP planned with 1 sector, by not more than 3 hours; or
    - For augmented flight crews with a FDP planned with 2 or 3 sectors, by not more than 2 hours;

- If on the final sector within an FDP that has been increased and further unforeseen operational circumstances occur after take-off, that will result in the permitted increase being exceeded, the flight may continue to the planned destination or alternate;

- The pilot-in-command, in case of unforeseen operational circumstances, which could lead to fatigue, may reduce the actual flight duty time and/or increase the rest period in order to reduce any detrimental effect on flight safety.

- The pilot-in-command shall consult all flight crew and other crew members where applicable on their alertness levels before deciding these modifications.

- The minimum rest period following an FDP that exceeded the maximum limits of the FDP Table due to unforeseen operational circumstances shall be increased by an amount at least equal to the extension of the FDP.

The discussions highlighted the importance of a clear definition / guidance material concerning what constitutes an unforeseen operational circumstance – when is a situation unforeseen and when is it not.

Science: When the science referred to in the section on the length of the basic FDP is used to establish a limitation, scientifically it is difficult to justify further extensions to a limitation that has been established, hence the reason why the use of this extension is solely at the pilot-in-command's discretion.

Limiting the extension to 1 hour for single pilot operations is deemed appropriate because there is no ability to discuss the situation with a second flight crew member nor is there a second flight crew member present to monitor the performance of the first flight crew member.

Harmonization: Most jurisdictions have some language that covers unforeseen operational circumstances.

Operational Experience: The current CARS have regulations with regards to unforeseen operational circumstances and for the most part it has worked well with the full understanding it is at the Captain's discretion.

Existing Regulation: 700.17

Summary of Positions: The working group reached consensus in respect to the general criteria for extensions due to unforeseen operational circumstances. There was resistance from some Working Group Member's regarding the requirement for an additional rest period as a result of the extension to the maximum FDP.

14.0 Unforeseen Operational Circumstances — Short-Term Re-Planning — Pilot-In-Command's Discretion

This section deals with short term re-planning resulting from unforeseen operational circumstances and the criteria to be followed when this occurs.

Recommendation:

- The air operator may request a split duty period to a scheduled FDP due to unforeseen operational circumstances.
- The pilot-in-command may accept the split duty or modifications to the schedule at the pilot-in-command's discretion.
- The pilot-in-command shall consult all crew members on their alertness levels before accepting the split duty or modifications to the schedule.
- When requesting the introduction of a split duty, the air operator shall make the request to the pilot-in-command before the start of the break on the ground;
- The criteria for increasing the FDP based on the rest period obtained in the break are contained in the section on Split Duty.

Science: There is general consensus in the scientific community that there is a minute for minute recuperative value for actual sleep obtained when the duration of the sleep period is a minimum of 20 minutes. The key words being actual sleep not just a rest period provided thus the justification that this section is at the pilot-in-command's discretion.

Harmonization: The EASA CRD to NPA 2010-014 has a similar proposal.

Operational Experience: The concept of short term replanning is new to the CARs. There is experience with the use of split duty periods, but not in this manner.

Existing Regulation: N/A

Summary of Positions: There was general consensus with the following comments: some queried when this would actually happen since crew members are required to show up fit for duty, it would be unlikely that they would be able to get some actual sleep if given a split duty. Others felt that if the split duty occurred during the WOCL there was a good chance that actual sleep would be achieved. One should familiarize themselves with the split duty concept in 700.62.

15.0 Delayed Reporting Time

This section describes the requirements for delaying the reporting time of the flight crew prior to them leaving their rest facility. This is intended to accommodate changes to the schedule that are made after the flight crew member's rest period has begun.

Recommendation: Where a flight crew member is notified by the air operator of a delay in reporting time before leaving his rest facility, the FDP is calculated as follows:

- when the delay is less than 4 hours, the maximum FDP (maximum FDP from the FDP Table) shall be based on the more limiting of the original or the delayed reporting time and the FDP shall start at the actual reporting time;

- when the delay is 4 hours or more, the maximum FDP shall be based on the more limiting of the original or the delayed reporting time and the FDP starts 4 hours after the original reporting time;

- when the delay is 10 hours or more and the flight crew member is not further disturbed by the air operator until a mutually agreed hour, the elapsed time between the original and the delayed reporting time is considered a rest period. If, upon the resumption of duty, further delays occur, then the appropriate criteria in this paragraph and the two preceding paragraphs above shall be applied to the re-arranged reporting time.

Science: There is general consensus in the scientific community that there is a minute for minute recuperative value for actual sleep obtained when the duration of the sleep period is a minimum of 20 minutes. The duration of the sleep opportunity along with the time of day that it occurs will determine the ability of the individual to achieve sleep.

Harmonization: The EASA CRD to NPA 2010-014 has a similar proposal.

Operational Experience: This type of provision already exists.

Existing Regulation: 700.18

Summary of Positions: There was general consensus on this subject.

16.0 Cumulative Duty Hour Limitations

Cumulative duty hour limitations address cumulative fatigue by establishing weekly, monthly and yearly duty limits. This section offers several options in order to accommodate specific operational circumstances.

Recommendation: The science indicates that cumulative hours of work have a detrimental effect on human performance.

The total duration of duty periods to which a flight crew member is assigned shall not exceed:

- 1928 duty hours in any 365 consecutive days;
- 190 duty hours in any 28 consecutive days; and,

When using Time Free from Duty Option 1:

- 60 duty hours in any 7 consecutive days; or,

When using Time Free from Duty Option 2 (only applicable to remote operations where flight crew members are on a rotational schedule and/or not easily swapped out with replacement flight crew members and/or away from home base for an extended period of time):

- No early, late or night duties shall be scheduled
- No duty period scheduled greater than 12 hours and a maximum of 24 duty hours in any 2 consecutive days; and
- 70 duty hours in any 7 consecutive days.

Science: There were several studies found related to the effects of long working hours.

During a study of medical interns, the weekly scheduled hours on the traditional schedule were reduced from an average between 77 to 81 hours to an average of between 60 to 63 hours per week. This reduction of weekly work hours had a marked effect on diagnostic errors. “Interns also made 5.6 times as many serious diagnostic errors during the traditional schedule as during the intervention schedule (18.6 vs. 3.3 per 1000 patient days, $P<0.001$).”[40]

In a study by Dembe, et. al., “…multivariate analytical techniques were used to estimate the relative risk of long working hours per day, extended hours per week, long commute times, and overtime schedules on reporting a work related injury or illness, after adjusting for age, gender, occupation, industry, and region.

[40] Landrigan C, et.al, *Effect of Reducing Interns’ Work Hours on Serious Medical Errors in Intensive Care Units*, The New England Journal of Medicine, 28 October 2004, Vol. 351, 1838-1848.

Results: After adjusting for those factors, working in jobs with overtime schedules was associated with a 61% higher injury hazard rate compared to jobs without overtime. Working at least 12 hours per day was associated with a 37% increased hazard rate and working at least 60 hours per week was associated with a 23% increased hazard rate. A strong dose-response effect was observed, with the injury rate (per 100 accumulated worker-years in a particular schedule) increasing in correspondence to the number of hours per day (or per week) in the workers' customary schedule.

Conclusions: This study of nationally representative data from the United States adds to the growing body of evidence indicating that work schedules involving long hours or overtime substantially increases the risk for occupational injuries and injuries. Unlike previous studies, our investigation had the advantage of covering a large variety of jobs, and controlling for the potential confounding affect of age, gender, occupation, industry, and region. We analysed nearly 100 000 job records extending over a 13 year period, and employed several statistical techniques for quantifying the extent of risk. The results of this study suggest that jobs with long working hours are not more risky merely because they are concentrated in inherently hazardous industries or occupations, or because of the demographic characteristics of employees working those schedules. Our findings are consistent with the hypothesis that long working hours indirectly precipitate workplace accidents through a causal process, for instance, by inducing fatigue or stress in affected workers. However, our findings are also consistent with other hypotheses and thus we cannot be certain of a causal connection based on this study alone.

Results suggest that job schedules with long working hours are not more risky merely because they are concentrated in inherently hazardous industries or occupations, or because people working long hours spend more total time ''at risk'' for a work injury. Strategies to prevent work injuries should consider changes in scheduling practices, job redesign, and health protection programmes for people working in jobs involving overtime and extended hours." [41]

Caruso, et. al., found "…a pattern of deteriorating performance on psycho physiological tests as well as injuries while working long hours was observed across study findings, particularly with very long shifts and when 12-hour shifts combined with more than 40 hours of work a week. Four studies that focused on effects during extended shifts reported that the 9th to 12th hours of work were associated with feelings of decreased alertness and increased fatigue, lower cognitive function, declines in vigilance on task measures, and increased injuries. Two studies examining physicians who worked very long shifts reported deterioration on various measures of cognitive performance." [42]

[41] Dembe A, Erickson J, Delbos R, Banks S, *The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States*, Occupational and Environmental Medicine, 08 March 2005, Vol. 62, 588-597.

[42] Caruso C, Hitchcock E, Dick R, Russo J, Schmit J, *Overtime and Extended Work Shifts: Recent Findings on Illnesses, Injuries, and Health Behaviors*, U. S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, April 2004.

The Moebus report supported cumulative duty limitations: “Scientific research has established that fatigue [Spencer MB et al, 2006] and the risk of accidents and injuries [Folkard S & Tucker P, 2003] increases over successive work days, and that these increases are dissipated over periods of rest days. While the scientific evidence is not sufficient to support the precise values given in OPS 1.1100, most of the values contained in it seem “reasonable”, although we would prefer to see a lower limit (of perhaps 180 hours) per 28 consecutive days. Nevertheless, if it is deemed that the protection provided by the 190 hour duty limit in 28 days is “reasonable”…” [43]

Harmonization: EASA – the current EU OPS 1.1100 limits cumulative duty hours to:

- 190 duty hours in any 28 consecutive days, spread as evenly as practicable throughout this period; and
- 60 duty hours in any seven consecutive days.

The EASA Comment Response Document (CRD) to NPA 2010-014 proposes cumulative duty limits of:

- 60 duty hours in any 7 consecutive days;
- 110 duty hours in any 14 consecutive days; and
- 190 duty hours in any 28 consecutive days, spread as evenly as practicable throughout this period.

The UK CAP 371 sets cumulative duty limits at:

- 55 hours in any 7 consecutive days, but may be increased to 60 hours, when a rostered duty covering a series of duty periods, once commenced, is subject to unforeseen delays;
- 95 hours in any 14 consecutive days; and,
- 190 hours in any 28 consecutive days.

The FAA Final Rule sets cumulative limits at:

- 60 flight duty period hours in any 168 consecutive hours; and,
- 190 flight duty period hours in any 672 consecutive hours.

The EU Working Time Directive sets a maximum average of 48 hours per week.

Operational Experience: N/A.

Existing Regulation: N/A.

The Canada Labour Code (CLC) establishes cumulative daily, weekly (8 hours per day and 40 hours per week).and annual limits for hours of work. This proposal respects the

[43] EASA / Moebus Aviation, *Final Report “Scientific and Medical Evaluation of Flight Time Limitations”***,** 30 September 2008, page 14.

annual limit established under the Code. However, it should be noted that the CLC provides for the averaging of weekly and monthly limits under an averaging permit system, provided the annual hours of work limit is respected. In issuing an averaging permit Human Resource Development Canada (HRSDC) does not require a risk assessment of the hazard and risk associated with increased hours of work. Moreover, fatigue science does not support the use of averaging permits without an approved FRMS and an attendant risk assessment highlighting the risks and proposed risk mitigations relating to increased hours of work.

Summary of Positions: Opinions ranged from total opposition to the concept to values in the range of the recommendation. The working group was divided on this issue.

17.0 Flight Time Limitations

This section limits the amount of flight time permissible within the flight duty period and cumulatively on a monthly and yearly basis.

Recommendation: This recommendation is based more on operational experience and harmonization than on science.

The total flight time of the flights on which an individual flight crew member is assigned as an operating flight crew member shall not exceed:

- for single pilot operations, 8 flight hours in any 24 consecutive hours;
- 112 flight hours in any 28 consecutive days; and
- 1000 flight hours in any 365 consecutive days.

Science: There is limited scientific basis for a flight time limitation. Dr. Belenky was asked which of duty time or flight time would make a better measure. He felt that "… it would take some kind of metric like average duty time to predict cumulative fatigue, so I would favor setting limits on flight duty period and not setting limits on flight time per se. That said the literature is not clear on this subject and there are some papers that suggest an exponential increase in accident risk after 8 hours on duty. Science can provide guidance regarding flight duty period, however, operational experience is also relevant and can enable the effective application of crew resource management which coupled with good sleep practices can sustain performance. As far as cumulative fatigue is concerned, 1 day off in 7 is a good rule of thumb for mitigation." [44]

Graeber & Belenky, in their comments on the FAA Final Rule, commented that "there are no scientific papers supporting the idea that flight time should be treated differently from duty time except perhaps in so far as they involve differences in workload. Workload in the commercial aviation context is thought of primarily in terms of number of segments, specifically number of take offs and landings. Since both number of segments and circadian timing are taken care of in the duty time limits there is no rationale for putting further limits on flight time." [45]

Harmonization:

EASA – the current EU OPS 1.1100 sets flight hours limits of:

- 100 block hours in any 28 consecutive days; or
- 900 block hours in a calendar year.

[44] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 Dec 2012, page 8.
[45] Air Transport Association Of America**,** *Comments Of The Air Transport Association Of America, Inc*., ATA FDT final comments, November 15, 2010, page 121.

The EASA Comment Response Document (CRD) to NPA 2010-014 proposes flight hour limits of:

- 100 hours of flight time in any 28 consecutive days; and
- 900 hours of flight time in any calendar year; and
- 1000 hours of flight time in any 12 consecutive calendar months.

The FAA Final Rule sets flight hour limits of:

- 100 hours in any 672 consecutive hours and
- 1000 hours in any 365 consecutive calendar day period.

Operational Experience:

Existing Regulation: 700.15 (1).

Summary of Positions: There was consensus among working group members of the requirement to have flight time limitations. There were differing opinions on the values of the limitations.

18.0 Positioning

Positioning occurs when a flight crew member is required to travel at the request of the air operator from one point to another before or after a flight. This section defines the criteria under which positioning may occur and the required mitigations to address fatigue induced as a result of the positioning flight.

Recommendation: When an air operator assigns a flight crew member to positioning, the following shall apply:

- All of the time spent in positioning shall count as duty time;
- Positioning after reporting but prior to operating shall be included as part of the FDP but shall not count as a sector;
- Where positioning follows a FDP and the duration of duty period exceeds the permitted FDP, the subsequent rest period shall be as follows:
    - where the exceedance is 3 hours or less, the subsequent rest period shall be at least as long as the preceding duty period; or,
    - where the exceedance is greater than 3 hours, the subsequent rest period shall be at least twice as long as the preceding duty period.
    - an exceedance of greater than 3 hours may only take place with the joint agreement of the flight crew member and the air operator.

Science: The longer the duration of a duty period (wakefulness), the more time will be required in order to recover from the associated acute fatigue.

Requiring the subsequent rest period to be twice the duty period, following positioning for more than 4 hours in excess of the permitted FDP, provides for 2 sleep opportunities for recovery.

Harmonization: EASA – the current EU OPS does not specifically address positioning, however through the application of the definitions the current practice is the same as the proposal in the EASA Comment Response Document (CRD) to NPA 2010-014. Positioning prior a FDP counts as part of the FDP and positioning after a FDP only counts as duty. And the required rest period is as long as the preceding duty period.

The FAA Final Rule requires that a flight crew member must be given a rest period equal to the length of the deadhead transportation but not less than the minimum required rest.

Operational Experience: The current CARs require additional rest following positioning.

Existing Regulation: 700.20

Summary of Positions: The working group reached consensus on this issue. There were some varying opinions on the duration of the subsequent rest period.

19.0 Split Duty

A split duty is a flight duty period that may include a break in suitable accommodation. This allows the flight duty period to be extended beyond the maximum available FDP.

Recommendation: The maximum FDP may be increased where the air operator provides the flight crew member with a break during the FDP (split duty). The air operator shall provide a break in accordance with the following conditions:

- A break on the ground within the FDP shall have a minimum duration of 60 consecutive minutes in the suitable accommodation.
- The break will begin after the flight crew member is in the suitable accommodation.
- The break excludes travel time to and from the suitable accommodation.
- The maximum FDP may be increased by an amount of time equal to:
    - 100% of the duration of the break during the hours of 00:00 to 05:59 at the flight crew member's acclimatized time;
    - 50% of the duration of the break during the hours of 06:00 to 23:59 at the flight crew member's acclimatized time; or,
    - In the case of short-term re-planning due to unforeseen operational circumstances, 50% of the duration of the break; and,
- 45 minutes of the break in the suitable accommodation does not count towards the increase in the flight duty period.
- In the case of a FDP assignment, that includes a split duty, following a Standby assignment;
    - The flight crew member's SDP may be increased by a maximum of 2 hours if a break is provided in accordance with the criteria above.
    - This FDP is limited to 2 sectors following the break.

Science: The duration of a sleep due to napping that is longer than 20 minutes is recognized to have a restorative value on a minute for minute basis. [46] For example, if we say a person is effective for 14 hours from the time they wake up and they have a two hour sleep (nap) during the day, they should be effective for a period of 16 hours from the time they wake up.

[46] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group,* 13 Dec 2012, page 1.

It is recognized that there is a high probability that person will be able to sleep during the night. It is also recognized that there is a low probability that a person will be able to sleep for an extended period during the day.

Dr. Belenky stressed that a person on average needs 7 to 8 hours of actual sleep every 24 hours. All sleep obtained contributes to this daily requirement. [47]

Dr. Belenky was asked what amount of sleep could be reasonably expected to be obtained if a person were given a 7-8 hour sleep opportunity between the hours of 11:00am and 6:00pm local acclimatized time: "There is a mini-circadian dip in the late afternoon. I believe someone could get an hour or two of sleep in the afternoon (11am to 6pm) with sleep most likely during the mini circadian dip in the late afternoon. This is of course assuming a good night of sleep between 10:00pm and 6:00am immediately preceding that particular day. Sleep will be limited because you are you are topped off from your good night's sleep the night before. As the day progresses, you will gradually become more fatigued and sleepy however, this is counteracted by the circadian drive for wakefulness that builds up across the day peaking in mid to late evening. It is possible for a well-rested person to take a nap in the afternoon even if they had a full night of sleep the night immediately previous. However, a normal sleeper would not be able to sleep much more than an hour or two. In a person who had an early start in the morning and as a result a truncated sleep nighttime sleep, one could imagine that he/she would sleep more than an hour or two, perhaps, if sleep the night before was severely truncated even 3-4 hours if given the opportunity for an afternoon nap. This nap would be more likely later in the afternoon. In siesta cultures, people nap in the afternoon for an hour or more, but then they take the time off their night sleep." [48]

Harmonization: EASA – the current EU OPS 1.1105 permits the use of split duty. The EASA CRD to NPA 2010-014, CS FTL.1.225 also permits the use of split duty.

The FAA Final Rule 117.15 permits the use of split duty, but only at night.

Operational Experience: The CARs have a provision for split duty.

Existing Regulations: Flight Duty Time Limitations and Rest Periods - 700.16 (5) describe spilt duty provisions.

Summary of Positions: There was consensus on the concept of split duty. There were different opinions on the application of the concept.

Note: It is recognized that aerial applicator operations under CAR 702 are unique in that they are highly dependent on light wind conditions that generally occur in the early morning and late evening. An alternate scheme for these operations may

[47] FCFMWG, *Questions and Answers on the Fog of Fatigue - Belenky*, page 2.
[48] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 Dec 2012, pages 1 & 2.

need to be developed that respects the need for a minimum of 8 hours of sleep every 24 hours.

20.0 Standby

This section deals with standby the state of being available to be called for a flight. This section describes “Standby” where the flight crew member remains at their domicile or at suitable accommodation provided by the air operator; and the second called “Airport Standby” where the flight crew member remains at a location designated by the air operator, normally at or near an aerodrome, and is ready to accept a FDP assignment.

Recommendation: Standby

Where an air operator assigns a flight crew member to Standby, the air operator shall:

- notify the flight crew member in advance of the start time, end time, and nature [at domicile or hotel] of the SAP;
- notify the flight crew member:
    - at least 12 hours prior to the beginning of the SAP, if the assigned SAP does not infringe upon the WOCL; or
    - at least 32 hours prior to the beginning of the SAP, if the assigned SAP does infringe upon the WOCL.
- not shift the designated SAP by more than:
    - 2 hours earlier or 4 hours later than the preceding SAP; and,
    - a total of 8 hours from the original SAP start time in any 7 consecutive days unless the flight crew member is provided with 2 consecutive days free from all duties within the 7 consecutive days.
- if the shift of the start time of the SAP crosses 02:00, no additional shifts are permitted unless the flight crew member is provided with 2 consecutive days free from all duties prior to beginning a subsequently shifted SAP.
- not shift the start time of the SAP into the flight crew member’s WOCL without notifying the flight crew member of the SAP at least 24 hours prior to the beginning of the SAP,
- Not assign a flight crew member to a FDP outside of the aggregate maximum SDP unless;
    - the air operator provides the flight crew member with minimum 24 hours notice of the assignment, prior to the beginning of the FDP;
    - The air operator shall not provide this notification to the flight crew member between the hours of 22:30 to 07:30; and,

- the air operator shall not assign the flight crew member to any duties from the time of the notification until the beginning of the FDP.

When assigning a flight crew member to Standby, the air operator shall:

- not assign a flight crew member to a SAP that exceeds 14 hours;
- after a flight crew member is assigned to a FDP, the SAP ends;
- provide the flight crew member with a minimum rest period of 10 hours between SAPs;
- Calculate the SDP limits for un-augmented flight crew members for SAPs starting between:
  - 0200 and 1759: 18 hours
  - 1800 and 1859: 17 hours
  - 1900 and 2059: 16 hours
  - 2100 and 2259: 15 hours
  - 2300 and 0159: 14 hours
- Calculate the SDP limits for augmented flight crew members as follows:
  - the maximum SDP for a flight crew augmented with one additional flight crew member is 20 hours; in a class 1 or 2 rest facility
  - the maximum SDP for a flight crew augmented with two additional flight crew members is 22 hours; in a class 1 or 2 rest facility
- when the SAP begins between 02:00 and 05:59 (flight crew member's acclimatized time), the maximum SDP may be increased by 50% of the time period between 02:00 and 05:59 that the flight crew member was not disturbed by the air operator, to a maximum of 2 hours;
- not assign the flight crew member to a flight duty that exceeds either the SDP maximum or the FDP maximum from the FDP Tables (the lesser value is used);
- count all time spent on standby by a flight crew member as duty at a rate of 33% for the calculation of cumulative duty limitations.

Airport Standby

When assigning a flight crew member to Airport Standby, the air operator shall:

- consider the flight crew member to be on duty from the time of reporting at the aerodrome for the SAP until the end of the scheduled SAP;

- count all time spent by a flight crew member on airport standby as duty for the calculation of cumulative duty limitations;

- when the air operator assigns a flight crew member to flight duty during a SAP, use the start time of the SAP as the FDP start time in order to establish the maximum FDP available (FDP began when SAP began).

- provide the flight crew member with standby accommodation while assigned to airport standby.

- when the flight crew member has not been assigned to flight duty, provide the flight crew member with a minimum rest period prior to the next scheduled SAP or FDP.

Transition from SDP to SAP

Following a SDP and subsequent rest period, the flight crew member may resume the previously scheduled SAP in progress. When the air operator wishes to change the start time of the SAP, all provisions related to the shifting of the start time of the SAP apply.

When a flight crew member resumes a previously scheduled SAP in progress, as long as the end time of the SAP remains the same as the previously scheduled SAP end time, the SAP is not considered to have shifted. The SDP limit is calculated from the start of the previously scheduled SAP.

Example:

- Scheduled SAP – 05:00 to 19:00
- Assigned FDP – 07:00 to 20:00
- Rest period – 20:00 to 08:00
- Resumed SAP – 08:00 to 19:00 (SDP limit remains – 23:00 (05:00 + 18 hours))

Science: Due to the variability of a standby schedule (when combined with flight assignments) the schedule must ensure adequate opportunity for rest and not permit excessively flight duty assignments. Refer to the sections on FDP and Rest.

Harmonization: EASA – the current EU OPS 1.1125 and the EASA CRD to NPA 2010-014, permit the use of standby.

The FAA Final Rule 117.21 permits the use of standby / reserve.

Operational Experience: The CARs have reserve, standby, and on call provisions.

Existing Regulations: 700.21 / 720.21

Summary of Positions: There was consensus on this issue.

21.0 Rest Periods

This section defines the amount of basic minimum rest required as a result of a FDP or consecutive FDPs.

Recommendation: The air operator shall provide a flight crew member with basic minimum rest as follows:

- minimum rest period at home base: The minimum rest period provided before undertaking an FDP starting at home base shall be 12 hours (not less than 12 hours from the end a duty period to the beginning of a FDP);

- minimum rest period away from home base: The minimum rest period provided before undertaking a flight duty period starting away from home base shall be 10 hours in the suitable accommodation;

- where the air operator provides a suitable accommodation to the flight crew at home base, the away from home base provision may be applied (10 hours in the suitable accommodation); and,

- where the duration of duty period exceeds the maximum permitted FDP plus 1 hour (with the exception of positioning), the subsequent rest period shall be at least as long as the preceding duty period.

Science: The science shows that a regular rest period is required to mitigate acute fatigue. A report by Wright, et.al., found that an 8 hour sleep opportunity was not sufficient to sustain performance over a 32 day period. From the report:

“Chronic partial sleep loss has been reported to result in cumulative impairment of neurobehavioral functioning. Scheduled sleep episodes from four to six hr per 24-hr for one to two weeks in duration result in a level of performance equal to that observed after 24 to 48 hours of total sleep deprivation. The amount of sleep required to prevent cumulative decrements in performance across weeks of sustained work-rest schedules without a day off is unknown. In the present study, we examined whether an 8-hr scheduled sleep opportunity across a sustained 32-day work-rest schedule was sufficient to maintain high levels of performance.

These preliminary results suggest that an 8-hr scheduled sleep opportunity may not be sufficient to maintain performance levels for work-rest schedules that do not include days off or time for extra sleep, although other explanations related to repetitive performance of the task itself have yet to be excluded. These results are consistent with those from others showing a trend for worse performance near the end of a two-week period of 8-hr scheduled sleep. Taken together, these findings suggest that scheduling sleep to 8-hr per day in the laboratory may result in cumulative sleep restriction and that

a longer scheduled sleep episode or days off may be necessary to prevent cumulative sleep restriction."[49]

Van Dongen, et.al., found similar results concerning the sufficiency of an 8 hour sleep opportunity:

"With mixed-effects regression modeling of the psychomotor vigilance performance data, the critical wake period beyond which lapsing would be expected to increase was statistically estimated to be 15.84 ± 0.73 h (mean ± s.e.). For the average healthy young adult in the experiments, limiting daily wakefulness to this level would be expected to prevent the build-up of neurobehavioral deficits over days. Accordingly, per 24 h day, the average value for human sleep need to prevent cumulative neurobehavioral deficits would appear to be 8.16 h. Although we found no evidence that subjects had any significant neurobehavioral impairment at the beginning of sleep restriction, it is possible that the 8 h baseline sleep periods were not sufficiently long to completely prevent the build-up of neurobehavioral impairment." [50]

Belenky, et.al., in a complementary study to Van Dongen's, found that 9 hours time in bed (in a controlled laboratory environment) was required to obtain the 8 hours of sleep:

"Daytime performance changes were examined during chronic sleep restriction or augmentation and following subsequent recovery sleep. Sixty-six normal volunteers spent either 3 (n = 18), 5 (n = 16), 7 (n = 16), or 9 h (n = 16) daily time in bed (TIB) for 7 days (restriction/augmentation) followed by 3 days with 8 h daily TIB (recovery). In the 3-h group, speed (mean and fastest 10% of responses) on the psychomotor vigilance task (PVT) declined, and PVT lapses (reaction times greater than 500 ms) increased steadily across the 7 days of sleep restriction. In the 7- and 5-h groups speed initially declined, then appeared to stabilize at a reduced level; lapses were increased only in the 5-h group. In the 9-h group, speed and lapses remained at baseline levels.

Beginning on the fourth day and continuing for a total of 7 days (E1–E7) subjects were in one of four sleep conditions [9 h required TIB (22:00–07:00 h), 7 h required TIB (24:00–07:00 h), 5 h required TIB (02:00–07:00 h), or 3 h required TIB (04:00–07:00 h)], effectively one sleep augmentation condition, and three sleep restriction conditions.

Average Total Sleep Time over the 7 days of sleep restriction/augmentation were 7.93 h for the 9-h TIB group, 6.28 h for the 7-h TIB group, 4.66 h for the 5-h TIB group, and 2.87 h for the 3-h TIB group…" [51]

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[49] Wright KP, Hughes RJ, Hull JT, Czeisler CA, *Cumulative Neurobehavioral Performance Deficits on a 24-hr Day with 8-hr of Scheduled Sleep*, Journal Of Sleep And Sleep Disorders, Research Vol. 23, 15 April 2000, Abstract Supplement 2, page 36.

[50] Van Dongen H, Maislin G, Mullington J, Dinges D, *The Cumulative Cost of Additional Wakefulness: Dose-Response Effects on Neurobehavioral Functions and Sleep Physiology From Chronic Sleep Restriction and Total Sleep Deprivation*, Sleep, Vol. 26, No. 2, January 2003, 117-126.

[51] Belenky G, Wesensten N, Thorne D, Thomas M, Sing H, Redmond D, Russo M, Balkin T, *Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study***.** Journal of Sleep Research, 11 December 2003, Vol. 12, 1-12.

Dr. Belenky indicated that it takes a person 12 hours off duty to get 8 hours of sleep taking into account commuting and the necessities of living.[52]

From the Moebus Report, in reference to consecutive split duties, "…the total FDP of a split duty should never be extended beyond 14 hours in order to allow an absolute minimum of 10 hours daily rest." [53]

Harmonization:

EASA – the current EU OPS 1.1125 and the EASA CRD to NPA 2010-014, set the minimum rest period to be the greater of:

- the duration of the previous duty period;
- 12 hours at from base; or,
- 10 hours away from home.

The FAA Final Rule 117.25 provides for a 10 hour rest period. The current FAR 135.267(c) requires 10 hours of rest prior to and following a duty period.

Operational Experience: The CARs require an opportunity to obtain not less than eight consecutive hours of sleep in suitable accommodation, time to travel to and from that accommodation and time for personal hygiene and meals.

Existing Regulation: 700.16 (3) and 101.01 (definition of minimum rest period).

Summary of Positions: The working group reached consensus on the requirement for 8 hours of sleep in each 24 hour period.

[52] FCFMWG, *Questions and Answers on the Fog of Fatigue - Belenky*, page 2.
[53] EASA / Moebus Aviation, *Final Report "Scientific and Medical Evaluation of Flight Time Limitations"***,** 30 September 2008, page 21.

22.0 Time Free From Duty

This section defines the minimum time free from duty required to address cumulative fatigue. Two options for time free from duty are presented. Option 2 is intended for deployed operations of more than one week.

Recommendation: The air operator shall provide a flight crew member with additional time free from duty in accordance with one of the Options below:

Option 1:

- A crew member shall be provided a minimum of one single day free from duty in any 8 consecutive days;
- the beginning of the single day free from duty may be delayed by a maximum of 2 hours due to unforeseen operational circumstances. When this occurs the duration of the single day free from duty shall be extended by a minimum of 2 hours;
- a minimum of 4 single days free from duty within in any 28 consecutive days; or,

Option 2 (for use in deployed operations of more than one week):

- 5 consecutive days free from duty within every 20 consecutive days.

To transition between Options, 5 consecutive days free from duty are required.

Science: The Moebus Report found that there is a requirement for a weekly rest period:

A weekly rest period is essential to allow the dissipation of the cumulative fatigue that has been scientifically established to build up over consecutive periods of duty [Spencer MB et al, 2006]. However, scientific research has also established (i) that sleep duration depends crucially on the time of day at which individuals attempt to go to sleep [Folkard S et al, 2007], and (ii) that the duration of sleep may be severely truncated by the requirement to start work early [Folkard S & Barton J, 1993; Spencer MB & Robertson KA, 2000].

The basic requirement given in OPS 1.1110 para 2.1 is for a weekly rest period of 36-hours including two local nights which are defined as a period of 8 hours falling between 22:00 and 08:00 local time. This means that the duty following the second local night could not start before 06:00 and under normal circumstances this should allow two reasonably long night sleeps to be taken, and hence for any cumulative fatigue to be dissipated. However, the “exception” would allow the second local night to start at 20:00 (and hence presumably to end at 04:00), hence the wording of Question 9. We consider this “exception” to be unacceptable, and to negate the purpose of the weekly rest

period. The reasons are (i) that it would severely truncate the second local night sleep, by as much as three hours [Folkard S & Barton J, 1993; Spencer MB & Robertson KA, 2000], and hence (ii) that it would result in aircrew starting their week of consecutive duty periods in a fatigued state. This follows from the fact that the extra four hours allowed for the weekly rest period would occur at a suboptimal time of day for sleep. In short, we would argue that the "exception" (i.e. the last sentence) should be omitted from OPS 1.1110 para 2.1…" [54]

The weekly rest period addresses the cumulative fatigue: As discussed in our responses to questions 1 & 9, it is well established that fatigue and risk show a cumulative build up over consecutive duties." [55]

Belenky, et.al., found that following the 7 days of restricted sleep, the subjects that were subjected to the 7 or 5 hours time in bed, did not recover to pre-experiment performance levels during the 3 days of recovery (9 hours time in bed): "During recovery, PVT speed in the 7- and 5-h groups (and lapses in the 5-h group) remained at the stable, but reduced levels seen during the last days of the experimental phase, with no evidence of recovery. Speed and lapses in the 3-h group recovered rapidly following the first night of recovery sleep; however, recovery was incomplete with speed and lapses stabilizing at a level comparable with the 7- and 5-h groups. Performance in the 9-h group remained at baseline levels during the recovery phase. These results suggest that the brain adapts to chronic sleep restriction. In mild to moderate sleep restriction this adaptation is sufficient to stabilize performance, although at a reduced level. These adaptive changes are hypothesized to restrict brain operational capacity and to persist for several days after normal sleep duration is restored, delaying recovery."[56]

"Following chronic, mild to moderate sleep restriction (5 or 7 h TIB), 3 days of recovery sleep (8-h TIB) did not restore performance to baseline levels." [57]

Dr. Belenky was asked if there is "sleep debt' with 8 hours sleep. He responded probably not "…however, there is cumulative fatigue with being on duty day in and day out for weeks at a time. Having no day off wears you down. Time off is necessary to keep people refreshed even if they are getting normal amounts of sleep. Cultural patterns suggest an 8-12 hour work day to avoid cutting into your sleep and at least a

[54] EASA / Moebus Aviation, *Final Report "Scientific and Medical Evaluation of Flight Time Limitations"***,** 30 September 2008, page 26.
[55] EASA / Moebus Aviation, Final *Report "Scientific and Medical Evaluation of Flight Time Limitations"***,** 30 September 2008, page 27.
[56] Belenky G, Wesensten N, Thorne D, Thomas M, Sing H, Redmond D, Russo M, Balkin T, *Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study***.** Journal of Sleep Research, 11 December 2003, Vol. 12, page 1.
[57] Belenky G, Wesensten N, Thorne D, Thomas M, Sing H, Redmond D, Russo M, Balkin T, *Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study***.** Journal of Sleep Research, 11 December 2003, Vol. 12, page 12.

day off each week to avoid being worn down by working every day is sustainable over the long haul." [58]

Dr. Belenky was also asked what maximum duty period and corresponding rest period, day after day; over an extended time does the science support? He responded that "…we understand very little about cumulative fatigue over weeks, months, and years. Most cultures favor one or two days off in 7 days. If you are doing nothing else, for example you are a deployed soldier, a submariner, or working on an oil rig for two weeks straight then you can manage for long periods (weeks) with 12 hours on duty and 12 hours off duty. Having days off would change this equation and allow for longer duty periods, for example, the 14 on 10 off schedule you mention.[59]

Dr. Belenky also commented on the fragility of multiple consecutive days of work: "12 on 12 off deployed in a camp – sustainable, but all you do is work, sleep. Throw in a night shift – major disruption to a (fragile) situation already in delicate balance." [60]

When asked how many consecutive days in a row to work would be acceptable with mitigations that limit the average duty day, WOCL infringement, and sectors, Dr. Belenky stated that in his "…opinion, 15 days is ok. I wouldn't do it for a month. I am not aware of any scientific findings one way or the other. More than 7 days of consecutive duty is probably manageable with mitigations of the sort you describe. However, the rule of thumb of one or two days off in seven still applies." [61]

The NASA Technical Memorandum recommended that period for recovery should be a minimum of 36 continuous hours, to include two consecutive nights of recovery sleep, within a 7-day period and, if the preceding duty contained any WOCL infringement, that this period be increased to 48 hours.[62]

Harmonization: EASA – the current EU OPS 1.1110 and the EASA CRD to NPA 2010-014 requires a 36-hour period including two local nights, such that there shall never be more than 168 hours between the end of one weekly rest period and the start of the next. The EASA Comment Response Document (CRD) to NPA 2010-014 also requires 2 consecutive days off twice every 28 days.

The FAA Final Rule 117.25 provides for at least 30 consecutive hours free from all duty in any 168 consecutive hour period.

[58] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 December 2012, pages 7 & 8.
[59] FCFMWG, *Questions and Answers on the Fog of Fatigue - Belenky*, page 3.
[60] FCFMWG, *Questions for Dr Belenky April 2011*, page 1.
[61] FCFMWG, *RDIMS 7362144 Transcript of questions with Dr Belenky – Fatigue Management Working Group***,** 13 December 2012, page 9.
[62] Dinges D, Graeber C, Rosekind M, Samel A, Wegmann H, *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation*, NASA Technical Memorandum 110404, May 1996, page 5.

Operational Experience: The CARs have 3 options for time free from duty:

- 36 consecutive hours free from duty within each 7 consecutive days;
- 3 consecutive days free from duty within each 17 consecutive days; or
- one period of at least 24 consecutive hours 13 times within each 90 consecutive days and 3 times within each 30 consecutive days

The scientific evidence does not support the third option nor the options described in the Standard.

Existing Regulation: 700.19 & 720.19.

Summary of Positions: The working group did not reach consensus on this issue.

23.0 Additional Rest Due To Disruptive Schedules

This section defines the amount of additional rest required to counteract fatigue as a result of a disruptive schedule.

Recommendation: Disruptive schedule provisions do not apply when the crew member is in a location where local time differs with the flight crew member's acclimatized time by more than 4 hours.

- When a flight crew member is scheduled to transition from:

  - a late or night duty to an early duty; or
  - an early duty to a late or night duty:

  the air operator shall provide the flight crew member with a minimum of one local night's rest in between the two FDPs.

Science: The science is clear on the disruptive nature of schedules that prevent a person from sleeping on regular schedule.

The NASA Technical Memorandum states: "Required sleep and appropriate awake time off promote performance and alertness. These are especially critical when challenged with extended periods of wakefulness (i.e., duty) and circadian disruption (i.e., altered work/rest schedule). Recovery is important to reduce cumulative effects and to return an individual to usual levels of performance and alertness." [63]

In his comments to EASA, Spencer wrote: "The duration of sleep following a late finish gradually reduces with progressively later duty-end times. After waking, individuals tend to remain in bed for around 20 minutes, possibly in an attempt to obtain more sleep, before finally getting up. The end of sleep generally occurs in the late morning, when the circadian rhythm of body temperature is on an upward trend, and when sleep is more difficult to sustain. Prior to an early start, the amount of sleep obtained reduces with progressively earlier start times. Individuals advance their bedtime, but normally take over a half an hour to fall asleep, because the early to mid-evening is a particularly difficult time at which to initiate sleep.

A transition from a late finish to an early start without an intervening night's sleep will inevitably involve some sleep disruption and, without direct information, it is difficult to speculate on how aircrew would adjust their sleep pattern. However, these results from individual late finishes and early starts provide a strong argument for a redefinition of both, in order to limit the overall loss of sleep. The critical times appear to be around midnight for a late finish and 07:00 for an early start. Compared with the current

[63] Dinges D, Graeber C, Rosekind M, Samel A, Wegmann H, *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation*, NASA Technical Memorandum 110404, May 1996, page 3.

definitions, this would entail an advance of an hour for a late finish and a delay of an hour for an early start. Thereby the combined sleep loss from consecutive duties, based on Figure 8, would be limited to approximately three hours." [64]

Harmonization: The EASA Comment Response Document (CRD) to NPA 2010-014 requires a local night's rest when transitioning between a late finish/night duty to an early start and increases the duration of the extended recovery rest period (36 to 60 hours) following these schedules.

Operational Experience: N/A

Existing Regulation: N/A

Summary of Positions: There was consensus on the principles of this issue.

[64] EASA**,** *Comment Response Document to NPA 2010-14A*, 18 January 2012, page 180.

24.0 Additional Rest Due To Time Zone Differences

This section defines the amount of rest required to counteract the fatigue effects induced by time zone differences.

Recommendation: The air operator shall provide the flight crew member with additional rest due to time zone differences as follows:

- when a duty period ends away from home base at a location where the local time zone differs by:
    - 4 hours from the time at the location of the start of the flight duty period, the minimum rest shall be 11 hours in the suitable accommodation; or,
    - more than 4 hours from the time at the location of the start of the flight duty period, the minimum rest shall be 14 hours in the suitable accommodation.

- when a duty period ends at home base and the local time zone differs by:
    - 4 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for more than 36 consecutive hours, the minimum rest shall be 13 hours ;
    - more than 4 hours and not more than 10 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for:
        - more than 60 consecutive hours or the returning FDP encroaches upon the flight crew member's WOCL, the flight crew member shall be provided with a minimum of 2 local night's rest prior to the start of the next flight duty period; or,
        - less than or equal to 60 consecutive hours and the returning FDP does not encroach on the flight crew member's WOCL, the flight crew member shall be provided with a minimum of 1 local night's rest prior to the start of the next flight duty period.
    - more than 10 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for:
        - more than 60 consecutive hours, the flight crew member shall be provided with a minimum of 3 local night's rest prior to the start of the next flight duty period; or,
        - less than or equal to 60 consecutive hours, the flight crew member shall be provided with a minimum of 2 local night's rest prior to the start of the next flight duty period.

Science: Flights that cross multiple time zones and then return to the origin are disruptive to the flight crews operating them: working through the night, sleeping during the day / out of circadian phase, and the duration of the layover all contribute to the disruption to the flight crew member's ability to sleep. This results in a longer duration rest period being required in order to recover following these types of flights.

The NASA Technical Memorandum recommended that for flight duty periods that cross 4 or more time zones, and that involve 48 hours or more away from the home-base/ domicile time zone, a minimum of 48 hours off-duty be allowed upon return to home base/domicile time. [65]

Samel found that because of sleep deprivation resulting from of the long haul operations, that on return to home base a period of at least 48 hours was required for recovery. [66]

Harmonization: The EASA Comment Response Document (CRD) to NPA 2010-014 provides for additional rest ranging between 36 an 72 hours to compensate for time zone differences.

The FAA Final Rule provides for additional rest for flights crossing more than 60° longitude or that were away from home base for more than 7 days: a minimum of 56 hours including 3 local nights rest.

Operational Experience: N/A.

Existing Regulation: N/A.

Summary of Positions: There was consensus on the principles of the issue.

[65] Dinges D, Graeber C, Rosekind M, Samel A, Wegmann H, *Principles and Guidelines for Duty and Rest Scheduling in Commercial Aviation*, NASA Technical Memorandum 110404, May 1996, page 8.
[66] Samel A, Wegmann H, Vejvoda M, *Air Crew Fatigue In Long-Haul Operations*, Accident Analysis and Prevention, 1997, Vol. 29, No. 4, page 449.

25.0 Consecutive Duties Infringing on the WOCL

This section defines the additional rest and mitigations required to counteract fatigue resulting from multiple consecutive duties that infringe on the WOCL.

Recommendation:

- FDP's are considered consecutive when scheduled without an intervening local night's rest.
- The air operator shall, following 3 consecutive FDPs that infringe upon the hours between 02:00 and 05:59, provide the flight crew member with a local night's rest;
- The break resulting from the split duty may be used to increase the FDP length as per the Split Duty provisions; or,

- The air operator may schedule a flight crew member to 5 consecutive FDPs that infringe upon the hours between 02:00 and 05:59 if:

    - each FDP includes a split duty with a scheduled break that provides the flight crew member with a minimum of 3 hours opportunity for rest in the suitable accommodation and the flight crew member is provided with this break;
    - following the 4th or 5th consecutive FDPs that infringe upon the hours between 02:00 and 05:59, provide the flight crew member with a minimum period of 56 consecutive hours free from duty; and,
    - the break on each of the duties infringing the WOCL shall not be used to increase the FDP as per Split Duty provisions.

Note: The provisions listed above do not apply to EMS (medevac). An alternate proposal providing additional rest or time off will provide for a mixed rotation where duties may infringe on the WOCL over consecutive nights duties.

Science: Folkard and Tucker found exponential increases in risk across successive night shifts: "As before, the frequency of incidents on each night was summed across the studies and then expressed relative to that on the first night shift. On average, risk was ~6% higher on the second night, 17% higher on the third night and 36% higher on the fourth night." [67]

Graeber and Belenky highlighted the importance of achieving the 7 to 8 hours of sleep per 24 hours and that this could be accomplished with split sleep: "…the issue of consecutive night duties is critically tied to the ability of the split duty rest periods to provide sufficient sleep. In a recent study comparing the sleep of physicians working

[67] Folkard S, Tucker P, *Shift work, safety and productivity*, Occupational Medicine**,** 01 February 2003, Vol. 53, No. 2, 95-101.

night shifts and day shifts (McDonald et al., 2010), it was found that they got equivalent amounts of sleep (i.e., approximately 7 hrs) when working either type of shift. When working days their sleep was consolidated into a single 7 hr sleep period at night. When working nights they split their sleep averaging 4 hrs of sleep off duty during the day and 3 hours of sleep on duty at night. Performance tested when going on and off shift was equivalent for day and night shifts.

It is therefore important to realize that the NASA study of night cargo operations showed that crews obtained 5 hrs sleep during each day after duty. This is similar to other studies on shift workers (Akerstedt, 2003) that found that they also slept five hours during the daylight hours. Obtaining another 2 hrs of sleep during split night duty should sustain performance across more than 3 consecutive nights. This is supported by Mollicone et. al., laboratory studies (2007, 2008) that showed that following restricted sleep for the same total sleep time performance was the same whether the sleep was consolidated into a single sleep period or split into two sleep periods." [68]

Harmonization: The EASA CRD to NPA 2010-014 provides for additional weekly rest following 4 or more night duties – 60 hours rest vice 36 hours.

The FAA Final Rule permits 3 consecutive night duties or 5 consecutive that include a minimum 2 hour rest period.

Operational Experience: N/A.

Existing Regulation: N/A.

Summary of Positions: The working group did not reach consensus on this issue.

[68] Air Transport Association Of America**,** *Comments Of The Air Transport Association Of America, Inc*., ATA FDT final comments, November 15, 2010, page 119.

26.0 Determining FDP Table Start Time

This section provides a method to account for the differences between the individual's acclimatized time and the time zone that the FDP begins in and to determine how long it takes an individual to acclimatize to a new time zone.

Recommendation:

- For an acclimatized flight crew member the maximum daily FDP is based on start time of the FDP using local time.

- For a not acclimatized flight crew member the maximum daily FDP is based on start time of FDP using the last acclimatized local time.

Time Zone Differences and Time Required to Acclimatize:

- This applies to flight crew member leaving home base and returning to home base.

- For the purpose of determining the FDP Table start time, Canada will be considered to encompass 5 time zones: Pacific, Mountain, Central, Eastern, and Atlantic. The Newfoundland Time zone is considered to be included in the Atlantic Time zone.

- when the time zone difference between local time and last acclimatized time does not exceed 4 hours, a flight crew member is considered acclimatized to the new time zone when all rest periods within a 72 consecutive hour period have occurred in the same time zone; or,

- when the time zone difference between local time and last acclimatized time exceeds 4 hours, a flight crew member is considered acclimatized to the new time zone when all rest periods within a 96 consecutive hour period have occurred in the same time zone.

Science: On average an individual can adapt to time zone changes at a rate of 1 time zone (1 hour) per day. However, this varies among individuals. The working group members felt that creating a rule to account for each individual's body clock would be overly complicated and difficult to manage. A broader brush approach was chosen that is in line with both the EASA proposal and the FAA final rule - an operational application of the science.

Harmonization: Both the EASA CRD to NPA 2010-014 and the FAA Final Rule approach the acclimatization question in a similar fashion.

Operational Experience: N/A.

Existing Regulation: N/A.

Summary of Positions: The working group reached consensus on this issue.

27.0 Fatigue Management Training

This section addresses the training required for all flight crew members to build awareness and knowledge of the causes and effects of fatigue.

Recommendation: Fatigue management training shall be provided to flight crew members, crew scheduling personnel and concerned management personnel.

The training syllabus shall address the possible causes and effects of fatigue, and fatigue countermeasures.

Science: N/A.

Harmonization: N/A.

Operational Experience: N/A.

Existing Regulation: N/A.

Summary of Positions: The working group reached consensus on this issue.

28.0 Controlled Rest on the Flight Deck

This section describes the procedures required for flight crew utilising controlled rest on the flight deck.

Recommendation: Maintain the current CAR requirements with one minor change:

The use of controlled rest on the flight deck shall be briefed prior to use.

Science: Supported.

Harmonization: N/A.

Operational Experience: The current CAR provisions have existed since 1996 and are effective.

Existing Regulation: 720.23.

Summary of Positions: The working group reached consensus on this issue with a minor change to the wording concerning “planned” in 720.23(2) (b).

29.0 Fatigue Risk Management Systems

This section defines the criteria for the development of voluntary fatigue management systems.

Recommendation: There was consensus on the issue of whether FRMS should be mandatory or not. The majority of Working Group Members felt it should not be mandatory. There was also agreement that when ULR operations are being conducted an approved FRMS is required. It is recommended that if planned extensions to the maximum flight duty period are requested, that an approved FRMS is required for this approval.

The group discussed the components of the FRMS and referenced both the ICAO and TCCA models for FRMS. Transport Canada agreed to reflect both the ICAO and TCCA approaches to regulatory development of FRMS and to develop an appropriate Canadian model of FRMS.

The Group agreed that FRMS implementation materials were required and that both the ICAO, IATA and IFALPA FRMS implementation guide as well as the Transport Canada toolbox would be an appropriate starting point.

Science: Transport Canada FRMS Toolkit, TP documents 14572-14578; ICAO Fatigue Risk Management System (FRMS) Implementation Guide For Operators FRMS Policy and Documentation, First Edition, Dr Greg Belenky presentation to FCFMWG.

Harmonization: ICAO

Operational Experience: N/A.

Existing Regulation: N/A.

Summary of Positions: 3 members felt FRMS should be mandatory; 6 members non-mandatory; 2 members absent.

Appendix 1 – Consolidated Recommendations

3.0 Air Operator Responsibilities

An air operator shall establish processes to (where applicable to the type of operation):

- publish duty schedules sufficiently in advance to provide the opportunity for flight crew members to plan adequate rest;
- ensure that flight duty periods are planned in order to enable flight crew members to remain sufficiently free from fatigue;
- specify reporting times to allow sufficient time for duties;
- take into account the relationship between the frequencies and pattern of flight duty periods and rest periods and give consideration to the cumulative effects of undertaking long duty hours combined with minimum rest periods;
- allocate duty schedules which avoid practices that cause a serious disruption of established sleep/work pattern such as alternating day/night duties;
- provide rest periods of sufficient time to enable flight crew members to overcome the effects of the previous duties and to be fit for duty by the start of the following flight duty period;
- plan days free of duty and notify flight crew members sufficiently in advance;
- ensure that flights are planned to be completed within the allowable flight duty period taking into account the time necessary for pre-flight duties, the flight and turn-around times as well as any changes to the schedule while on duty that may impact the number of sectors flown during that duty period;
- collect actual flight time / flight duty time data necessary to support the planning of flight operations;
    - change a schedule or crewing arrangements when: the planning for a given FDP or flight time is found to be unrealistic the operator must make the adjustment within 28 days following the discovery.
    - report adjustments made to comply with schedule reliability to TC every two months.
    - use all available data to plan realistic flight times and flight duty periods.

Note 1: Planning is considered unrealistic when the maximum FDP or flight time is exceeded on more than 10% of the time using a sampling of 10 events or 56 days; the operator may choose which sampling.

- require that flight crew members declare to the air operator whether or not they are fit for duty, prior to beginning a flight duty period.
- not assign a flight crew member, who has declared them self not fit for duty, to a flight duty period;
- remove a flight crew member who is no longer fit for duty from a flight duty period assignment.

- include flight times and duty times accumulated in other flight operations, flight training units, and military aircraft when calculating individual flight crew member flight time and flight duty period limitations. Document all procedures and processes related to the flight, duty, rest and all related provisions.

4.0 Flight Crew Member Responsibilities

A flight crew member shall:

- plan to use the rest periods provided by the air operator to obtain sleep to recover from a previous flight duty period and to be fit for duty in order to safely perform their duties during a subsequent flight duty period;
- prior to beginning a flight duty period, declare to the air operator whether or not they are fit for duty;
- not begin a flight duty period if they are unfit for duty;
- as soon as possible and as applicable, advise the air operator, the pilot-in-command, and other flight crew members, if during a flight duty period, they become unfit for duty; and,
- report to the air operator all flight time and duty times accumulated in operations for other air operators, flight training units, and military aircraft for calculation of flight time and flight duty period limitations.

5.0 Prescriptive Fatigue Management Documentation

An air operator shall document the policies, procedures and processes required for compliance with the applicable prescriptive limitations.

An air operator shall nominate a home base for each flight crew member.

With respect to Flight Duty Period (FDP) the air operator shall have processes:

- specifying how the pilot-in-command shall — in case of special circumstances which could lead to fatigue, and after consultation with the crew members affected — reduce the actual FDP and/or increase the rest period in order to eliminate any detrimental effect on flight safety.

- specifying how the pilot-in-command shall — in case of unforeseen operational circumstances which could lead to fatigue, and after consultation with the crew members affected, increase the actual FDP in order to manage any detrimental effect on flight safety.

- requiring the pilot-in-command to submit a report whenever an FDP is increased beyond the maximum or decreased at his/her discretion, in actual operations.

- for reviewing all increases beyond the maximum FDP to determine the percentage of FDPs that increase beyond the maximum FDP.

- for adjusting the schedule where any FDP that is shown to actually increase beyond the maximum FDP more than 10 percent of occasions.

- for notifying the Minister of an FDP that exceeds the maximum FDP by more than 1 hour and provide the review and analysis of the increase as soon as practicable.

- for providing food and drink opportunities for flight crew members.

The air operator shall document how the operator intends to meet the requirements, where applicable, with respect to the following FDP elements:

- Maximum basic daily FDP;
- Reductions of the maximum basic daily FDP dependent on the number of sectors flown;
- Reductions of the maximum basic daily FDP when this FDP would start, end or encompass the WOCL;
-

6.0 Nutrition - Providing the Flight Crew Member with Food and Drink Opportunities

When a FDP exceeds 6 hours, the air operator shall provide the flight crew member with food and drink opportunity every 6 hours. The timing of the food and drink opportunities should be scheduled at appropriate intervals.

7.0 Records of Flight and Duty Times and Rest Periods

Air operators shall maintain:

- Individual records of flight, duty and rest period for all crew members, for a period of 24 months, including:

  - Flight times;
  - Start, duration and end of each duty and FDP;
  - Rest periods and days free of all duties;

- Reports by the pilot-in-command on extended flight duty periods and extended flight hours, for a period of 24 months.

- Upon request the air operator shall provide a flight crew member copies of their individual records of flight and duty times and rest periods.

8.0 Flight Duty Period (FDP)

Instructions for using Table 1:

- Determine the start time of the FDP and determine the acclimatized time of the flight crew member; if these are the same, enter the Table in the row containing the local start time of the FDP. Otherwise see section 26.0 Determining FDP Table Start Time.
- Determine the planned number of sectors and the average sector flight time; using the row with the appropriate average sector flight time, locate the appropriate column for the number of sectors;
- The maximum FDP will be at the intersection of the Start FDP row and Number of Sectors column.

- When the air operator wishes to introduce schedule changes (additional sectors or reductions in sectors) during a FDP, the air operator has two options:

    - if the changes do not result in an increase to the originally planned FDP duration the original FDP limit remains unchanged; or
    - if the changes result in an increase to the originally planned FDP duration, adjust the FDP limit using Table 1 taking into account the new number of sectors flown. Any change in the average sector time as a result of the change in schedule will not be used to further reduce the length of the FDP.

Non-scheduled VFR helicopter operations always use Column A of the Table.

Table 1 - Maximum Daily FDP						
		Columns				
		A	B	C	D	E
Average Sector Flight Time		Number of Sectors				
> 50 minutes		1-3	4	5	6	7+
30 to 50 minutes		1-5	6-7	8-9	10-11	12+
< 30 minutes		1-8	9-11	12-14	15-17	18+
Rows	Start of FDP	Maximum FDP (hours)				
1	0700-1259	13.0	12.5	12.0	11.5	11.0
2	1300-1459	12.5	12.0	11.5	11.0	10.5
3	1500-1659	12.0	11.5	11.0	10.5	10.0
4	1700-1859	11.5	11.0	10.5	10.0	9.5
5	1900-2059	11.0	10.5	10.0	9.5	9.0
6	2100-2259	10.5	10.0	9.5	9.0	9.0
7	2300-0429	10.0	9.5	9.0	9.0	9.0
8	0430-0459	10.5	10.0	9.5	9.0	9.0
9	0500-0529	11.0	10.5	10.0	9.5	9.0
10	0530-0559	11.5	11.0	10.5	10.0	9.5
11	0600-0629	12.0	11.5	11.0	10.5	10.0
12	0630-0659	12.5	12.0	11.5	11.0	10.5

9.0 Planned Extensions to the Daily FDP

There is no science supporting the use of extensions without the use of split duty or augmented flight crews. It is not recommended, therefore that planned extensions, that do not include split duty or augmented flight crews, be allowed as part of a prescriptive flight and duty time regime. Under approved criteria, they may be acceptable as part of an implemented and approved fatigue risk management system.

10.0 Extension of FDP Due To In-Flight Rest

On aircraft equipped with in flight rest facilities, the maximum FDP value may be increased by:

- with one additional flight crew member:
    - Class 3 rest facility: + 1.5 hours / maximum FDP 14.0 hours
    - Class 2 rest facility: + 2.5 hours / maximum FDP 15.0 hours
    - Class 1 rest facility: + 3.5 hours / maximum FDP 15.0 hours
- With two additional flight crew members:
    - Class 3 rest facility: + 3.0 hours / maximum FDP 15.25 hours
    - Class 2 rest facility: + 4.25 hours / maximum FDP 16.5 hours
    - Class 1 rest facility: + 7.0 hours / maximum FDP 18.0 hours

Under the following conditions:

- The augmented FDP shall be limited to 3 sectors.
- The minimum opportunity for in-flight rest period shall be:
    - for flights planned as 1 sector, a balanced or optimized division of duty and rest between all of the flight crew members; or,
    - for flights planned as 2 or 3 sectors:
        - a period of 2 consecutive hours for the flight crew members seated at the aircraft controls for the final landing; and
        - a period of consecutive 90 minutes for all other flight crew members.
- All flight crew members shall commence their FDP at the same reporting place if they are part of an augmented crew. However, if the first sector of the FDP is planned at a flight time of less than 105 minutes, the

augmenting flight crew member may join the flight following the first sector (join for the second sector).

- At least one augmenting flight crew member shall be on the flight deck during all takeoffs and landings.

- In order to determine the maximum time available for in flight rest, the air operator shall use the phase of flight between climbing above 10,000 above aerodrome elevation and 15 minutes prior to the planned beginning of the descent.

- All the time spent in the rest facility shall be counted as FDP.

- The minimum rest following an augmented flight shall be at least as long as the preceding duty period or at least 14 hours in the suitable accommodation or 16 hours at home base, whichever is the greater (other provisions may also apply to the length of the rest period – time zone differences).

- Where a flight crew is augmented by the addition of at least one flight crew member, the total flight time accumulated during the flight shall be logged by all flight crew members for the purposes of calculating the maximum flight times.

- An in flight rest facility shall be provided for each augmenting flight crew member.

11.0 Unaugmented Long Range Flights

For flights operated by un-augmented flight crews:

- When a FDP includes a sector with a planned flight time greater than 10 hours the maximum FDP in the table is reduced by 1 hour.

- When a FDP infringes on the crewmember's WOCL and includes a sector with a planned flight time greater than 7 hours, no additional sector can be operated after the long-range sector.

- An additional sector may be operated after the long-range sector, provided the operation is conducted as part of an approved fatigue risk management system.

12.0 Ultra Long Range Flights

The ULR operations shall only be conducted as part of an approved fatigue risk management system.

13.0 Unforeseen Operational Circumstances — Pilot-In-Command's Discretion

The conditions for the modification of the limits on flight duty, duty and rest periods by the pilot-in-command in the case of unforeseen operational circumstances, shall comply with the following:

- The maximum daily FDP may be increased as follows:
    - For single pilot operations, by not more than 1 hour;
    - For un-augmented flight crews, by not more than 2 hours;
    - For augmented flight crews with a FDP planned with 1 sector, by not more than 3 hours; or
    - For augmented flight crews with a FDP planned with 2 or 3 sectors, by not more than 2 hours;

- If on the final sector within an FDP that has been increased and further unforeseen operational circumstances occur after take-off, that will result in the permitted increase being exceeded, the flight may continue to the planned destination or alternate;

- The pilot-in-command, in case of unforeseen operational circumstances, which could lead to fatigue, may reduce the actual flight duty time and/or increase the rest period in order to reduce any detrimental effect on flight safety.

- The pilot-in-command shall consult all flight crew and other crew members where applicable on their alertness levels before deciding these modifications.

- The minimum rest period following an FDP that exceeded the maximum limits of the FDP Table due to unforeseen operational circumstances shall be increased by an amount at least equal to the extension of the FDP.

14.0 Unforeseen Operational Circumstances — Short-Term Re-Planning — Pilot-In-Command's Discretion

- The air operator may request a split duty period to a scheduled FDP due to unforeseen operational circumstances.

- The pilot-in-command may accept the split duty or modifications to the schedule at the pilot-in-command's discretion.

- The pilot-in-command shall consult all crew members on their alertness levels before accepting the split duty or modifications to the schedule.

- When requesting the introduction of a split duty, the air operator shall make the request to the pilot-in-command before the start of the break on the ground;

- The criteria for increasing the FDP based on the rest period obtained in the break are contained in the section on Split Duty.

15.0 Delayed Reporting Time

This is intended to accommodate changes to the schedule that are made after the flight crew member's rest period has begun.

Where a flight crew member is notified by the air operator of a delay in reporting time before leaving his rest facility, the FDP is calculated as follows:

- when the delay is less than 4 hours, the maximum FDP (maximum FDP from the FDP Table) shall be based on the more limiting of the original or the delayed reporting time and the FDP shall start at the actual reporting time;

- when the delay is 4 hours or more, the maximum FDP shall be based on the more limiting of the original or the delayed reporting time and the FDP starts 4 hours after the original reporting time;

- when the delay is 10 hours or more and the flight crew member is not further disturbed by the air operator until a mutually agreed hour, the elapsed time between the original and the delayed reporting time is considered a rest period. If, upon the resumption of duty, further delays occur, then the appropriate criteria in this paragraph and the two preceding paragraphs above shall be applied to the re-arranged reporting time.

16.0 Cumulative Duty Hour Limitations

The total duration of duty periods to which a flight crew member is assigned shall not exceed:

- 1928 duty hours in any 365 consecutive days;
- 190 duty hours in any 28 consecutive days; and,

When using Time Free from Duty Option 1:

- 60 duty hours in any 7 consecutive days; or,

When using Time Free from Duty Option 2 (only applicable to remote operations where flight crew members are on a rotational schedule and/or not easily swapped out with replacement flight crew members and/or away from home base for an extended period of time):

- No early, late or night duties shall be scheduled
- No duty period scheduled greater than 12 hours and a maximum of 24 duty hours in any 2 consecutive days; and
- 70 duty hours in any 7 consecutive days.

17.0 Flight Time Limitations

The total flight time of the flights on which an individual flight crew member is assigned as an operating flight crew member shall not exceed:

- for single pilot operations, 8 flight hours in any 24 consecutive hours;
- 112 flight hours in any 28 consecutive days; and
- 1000 flight hours in any 365 consecutive days.

18.0 Positioning

When an air operator assigns a flight crew member to positioning, the following shall apply:

- All of the time spent in positioning shall count as duty time;

- Positioning after reporting but prior to operating shall be included as part of the FDP but shall not count as a sector;

- Where positioning follows a FDP and the duration of duty period exceeds the permitted FDP, the subsequent rest period shall be as follows:
    - where the exceedance is 3 hours or less, the subsequent rest period shall be at least as long as the preceding duty period; or,
    - where the exceedance is greater than 3 hours, the subsequent rest period shall be at least twice as long as the preceding duty period.
    - an exceedance of greater than 3 hours may only take place with the joint agreement of the flight crew member and the air operator.

19.0 Split Duty

The maximum FDP may be increased where the air operator provides the flight crew member with a break during the FDP (split duty). The air operator shall provide a break in accordance with the following conditions:

- A break on the ground within the FDP shall have a minimum duration of 60 consecutive minutes in the suitable accommodation.
- The break will begin after the flight crew member is in the suitable accommodation.
- The break excludes travel time to and from the suitable accommodation.
- The maximum FDP may be increased by an amount of time equal to:
    - 100% of the duration of the break during the hours of 00:00 to 05:59 at the flight crew member's acclimatized time;
    - 50% of the duration of the break during the hours of 06:00 to 23:59 at the flight crew member's acclimatized time; or,
    - In the case of short-term re-planning due to unforeseen operational circumstances, 50% of the duration of the break; and,
- 45 minutes of the break in the suitable accommodation does not count towards the increase in the flight duty period.
- In the case of a FDP assignment, that includes a split duty, following a Standby assignment;
    - The flight crew member's SDP may be increased by a maximum of 2 hours if a break is provided in accordance with the criteria above.
    - This FDP is limited to 2 sectors following the break.

20.0 Standby

Where an air operator assigns a flight crew member to Standby, the air operator shall:

- notify the flight crew member in advance of the start time, end time, and nature [at domicile or hotel] of the SAP;

- notify the flight crew member:

    - at least 12 hours prior to the beginning of the SAP, if the assigned SAP does not infringe upon the WOCL; or
    - at least 32 hours prior to the beginning of the SAP, if the assigned SAP does infringe upon the WOCL.

- not shift the designated SAP by more than:

    - 2 hours earlier or 4 hours later than the preceding SAP; and,
    - a total of 8 hours from the original SAP start time in any 7 consecutive days unless the flight crew member is provided with 2 consecutive days free from all duties within the 7 consecutive days.

- if the shift of the start time of the SAP crosses 02:00, no additional shifts are permitted unless the flight crew member is provided with 2 consecutive days free from all duties prior to beginning a subsequently shifted SAP.

- not shift the start time of the SAP into the flight crew member's WOCL without notifying the flight crew member of the SAP at least 24 hours prior to the beginning of the SAP,

- Not assign a flight crew member to a FDP outside of the aggregate maximum SDP unless;

    - the air operator provides the flight crew member with minimum 24 hours notice of the assignment, prior to the beginning of the FDP;
    - The air operator shall not provide this notification to the flight crew member between the hours of 22:30 to 07:30; and,
    - the air operator shall not assign the flight crew member to any duties from the time of the notification until the beginning of the FDP.

When assigning a flight crew member to Standby, the air operator shall:

- not assign a flight crew member to a SAP that exceeds 14 hours;

- after a flight crew member is assigned to a FDP, the SAP ends;

- provide the flight crew member with a minimum rest period of 10 hours between SAPs;

- Calculate the SDP limits for un-augmented flight crew members for SAPs starting between:
  - 0200 and 1759: 18 hours
  - 1800 and 1859: 17 hours
  - 1900 and 2059: 16 hours
  - 2100 and 2259: 15 hours
  - 2300 and 0159: 14 hours

  - Calculate the SDP limits for augmented flight crew members as follows: the maximum SDP for a flight crew augmented with one additional flight crew member is 20 hours; in a class 1 or 2 rest facility
  - the maximum SDP for a flight crew augmented with two additional flight crew members is 22 hours; in a class 1 or 2 rest facility

- when the SAP begins between 02:00 and 05:59 (flight crew member's acclimatized time), the maximum SDP may be increased by 50% of the time period between 02:00 and 05:59 that the flight crew member was not disturbed by the air operator, to a maximum of 2 hours;

- not assign the flight crew member to a flight duty that exceeds either the SDP maximum or the FDP maximum from the FDP Tables (the lesser value is used);

- count all time spent on standby by a flight crew member as duty at a rate of 33% for the calculation of cumulative duty limitations.

Airport Standby

When assigning a flight crew member to Airport Standby, the air operator shall:

- consider the flight crew member to be on duty from the time of reporting at the aerodrome for the SAP until the end of the scheduled SAP;

- count all time spent by a flight crew member on airport standby as duty for the calculation of cumulative duty limitations;

- when the air operator assigns a flight crew member to flight duty during a SAP, use the start time of the SAP as the FDP start time in order to establish the maximum FDP available (FDP began when SAP began).

- provide the flight crew member with standby accommodation while assigned to airport standby.

- when the flight crew member has not been assigned to flight duty, provide the flight crew member with a minimum rest period prior to the next scheduled SAP or FDP.

Transition from SDP to SAP

Following a SDP and subsequent rest period, the flight crew member may resume the previously scheduled SAP in progress. When the air operator wishes to change the start time of the SAP, all provisions related to the shifting of the start time of the SAP apply.

When a flight crew member resumes a previously scheduled SAP in progress, as long as the end time of the SAP remains the same as the previously scheduled SAP end time, the SAP is not considered to have shifted. The SDP limit is calculated from the start of the previously scheduled SAP.

Example:

- Scheduled SAP – 05:00 to 19:00
- Assigned FDP – 07:00 to 20:00
- Rest period – 20:00 to 08:00
- Resumed SAP – 08:00 to 19:00 (SDP limit remains – 23:00 (05:00 + 18 hours))

21.0 Rest Periods

The air operator shall provide a flight crew member with basic minimum rest as follows:

- minimum rest period at home base: The minimum rest period provided before undertaking an FDP starting at home base shall be 12 hours (not less than 12 hours from the end a duty period to the beginning of a FDP);

- minimum rest period away from home base: The minimum rest period provided before undertaking a flight duty period starting away from home base shall be 10 hours in the suitable accommodation;

- where the air operator provides a suitable accommodation to the flight crew at home base, the away from home base provision may be applied (10 hours in the suitable accommodation); and,

- where the duration of duty period exceeds the maximum permitted FDP plus 1 hour (with the exception of positioning), the subsequent rest period shall be at least as long as the preceding duty period.

22.0 Time Free From Duty

The air operator shall provide a flight crew member with additional time free from duty in accordance with one of the Options below:

Option 1:

- A crew member shall be provided a minimum of one single day free from duty in
  - any 8 consecutive days;
  - the beginning of the single day free from duty may be delayed by a maximum of 2 hours due to unforeseen operational circumstances. When this occurs the duration of the single day free from duty shall be extended by a minimum of 2 hours;
  - a minimum of 4 single days free from duty within in any 28 consecutive days; or,

Option 2 (for use in deployed operations of more than one week):

- 5 consecutive days free from duty within every 20 consecutive days.

To transition between Options, 5 consecutive days free from duty are required.

23.0 Additional Rest Due To Disruptive Schedules

Disruptive schedule provisions do not apply when the crew member is in a location where local time differs with the flight crew member's acclimatized time by more than 4 hours.

- When a flight crew member is scheduled to transition from:
  - a late or night duty to an early duty; or
  - an early duty to a late or night duty:

  the air operator shall provide the flight crew member with a minimum of one local night's rest in between the two FDPs.

24.0 Additional Rest Due To Time Zone Differences

The air operator shall provide the flight crew member with additional rest due to time zone differences as follows:

- when a duty period ends away from home base at a location where the local time zone differs by:
    - 4 hours from the time at the location of the start of the flight duty period, the minimum rest shall be 11 hours in the suitable accommodation; or,
    - more than 4 hours from the time at the location of the start of the flight duty period, the minimum rest shall be 14 hours in the suitable accommodation.

- when a duty period ends at home base and the local time zone differs by:
    - 4 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for more than 36 consecutive hours, the minimum rest shall be 13 hours ;
    - more than 4 hours and not more than 10 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for:
        - more than 60 consecutive hours or the returning FDP encroaches upon the flight crew member's WOCL, the flight crew member shall be provided with a minimum of 2 local night's rest prior to the start of the next flight duty period; or,
        - less than or equal to 60 consecutive hours and the returning FDP does not encroach on the flight crew member's WOCL, the flight crew member shall be provided with a minimum of 1 local night's rest prior to the start of the next flight duty period.
    - more than 10 hours from the time at the location of the start of the flight duty period and the flight crew member has been away from home base for:
        - more than 60 consecutive hours, the flight crew member shall be provided with a minimum of 3 local night's rest prior to the start of the next flight duty period; or,
        - less than or equal to 60 consecutive hours, the flight crew member shall be provided with a minimum of 2 local night's rest prior to the start of the next flight duty period.

25.0 Consecutive Duties Infringing on the WOCL

- FDP's are considered consecutive when scheduled without an intervening local night's rest.
- The air operator shall, following 3 consecutive FDPs that infringe upon the hours between 02:00 and 05:59, provide the flight crew member with a local night's rest;
- The break resulting from the split duty may be used to increase the FDP length as per the Split Duty provisions; or,

- The air operator may schedule a flight crew member to 5 consecutive FDPs that infringe upon the hours between 02:00 and 05:59 if:

    - each FDP includes a split duty with a scheduled break that provides the flight crew member with a minimum of 3 hours opportunity for rest in the suitable accommodation and the flight crew member is provided with this break;
    - following the 4th or 5th consecutive FDPs that infringe upon the hours between 02:00 and 05:59, provide the flight crew member with a minimum period of 56 consecutive hours free from duty; and,
    - the break on each of the duties infringing the WOCL shall not be used to increase the FDP as per Split Duty provisions.

Note: The provisions listed above do not apply to EMS (medevac). An alternate proposal providing additional rest or time off will provide for a mixed rotation where duties may infringe on the WOCL over consecutive nights duties.

26.0 Determining FDP Table Start Time

- For an acclimatized flight crew member the maximum daily FDP is based on start time of the FDP using local time.

- For a not acclimatized flight crew member the maximum daily FDP is based on start time of FDP using the last acclimatized local time.

Time Zone Differences and Time Required to Acclimatize:

- This applies to flight crew member leaving home base and returning to home base.

- For the purpose of determining the FDP Table start time, Canada will be considered to encompass 5 time zones: Pacific, Mountain, Central, Eastern, and

Atlantic. The Newfoundland Time zone is considered to be included in the Atlantic Time zone.

- when the time zone difference between local time and last acclimatized time does not exceed 4 hours, a flight crew member is considered acclimatized to the new time zone when all rest periods within a 72 consecutive hour period have occurred in the same time zone; or,
- when the time zone difference between local time and last acclimatized time exceeds 4 hours, a flight crew member is considered acclimatized to the new time zone when all rest periods within a 96 consecutive hour period have occurred in the same time zone.

27.0 Fatigue Management Training

Fatigue management training shall be provided to flight crew members, crew scheduling personnel and concerned management personnel.

The training syllabus shall address the possible causes and effects of fatigue, and fatigue countermeasures.

28.0 Controlled Rest on the Flight Deck

Maintain the current CAR requirements with one minor change in 720.23(2)(b):

The use of controlled rest on the flight deck shall be briefed prior to use.

29.0 Fatigue Risk Management Systems

There was consensus on the issue of whether SMS should be mandatory or not. The majority of Working Group Members felt it should not be mandatory. There was also agreement that when ULR operations are being conducted or regular extensions to the maximum flight duty period are required, an approved FRMS is required.

The group discussed the components of the FRMS and referenced both the ICAO and TCCA models for FRMS. Transport Canada agreed to reflect both the ICAO and TCCA approaches to regulatory development of FRMS and to develop an appropriate Canadian model of FRMS.

The Group agreed that FRMS implementation materials were required and that both the ICAO, IATA and IFALPA FRMS implementation guide as well as the Transport Canada toolbox would be an appropriate starting point.

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Appendix 3 – Terms Of Reference - Canadian Aviation Regulation Advisory Council (CARAC) Flight Crew Fatigue Management Working Group

(RDIMS 5351150)

BACKGROUND

Transport Canada's current flight time and duty time limitations and rest periods (FDT&RP) regulations were published in 1996. The requirements are based on an agreement made by the Commercial Air Service Operations Working Group in 1994. Since then, the International Civil Aviation Organization (ICAO) has amended Annex 6 to the *Convention on International Civil Aviation* to include a series of recommendations for developing FDT&RP requirements. While Transport Canada remains in compliance with the Annex, a review of the SARP and the latest science on fatigue is required to ensure that Transport Canada's regulatory framework for flight crew operating in accordance with CAR 705, 704, 703, 702 and 604 is current.

Since the FDT&RP requirements were published, Transport Canada along with the government of Canada has shifted its approach to regulatory development from being prescriptive to being performance-based. This shift has provided a more, output-based approach to rule making that has facilitated the development of a risk management-based approach to safety and compliance management. In addition, the ICAO and other regulatory authorities are looking beyond the prescriptive FDT&RP approach to the management of fatigue and are promoting a performance-based approach to managing fatigue-related hazards through a fatigue risk management system (FRMS). ICAO has developed a SARP entitled Fatigue Management that includes both flight time, flight duty period, duty period, and rest period limitations and proposed FRMS requirements

PURPOSE

The purpose of the Working Group is three-fold:

1. To review the existing FDT&RP regulatory scheme pertaining to flight crew with reference to and utilising current scientific data relating to fatigue.

2. To review the basic principles of the fatigue risk management system approach to fatigue management as it would apply to flight crew with reference to and utilising current scientific data relating to fatigue.

3. To determine the commonalities and differences with respect to the FDT &RP and FRMS approach to the management of fatigue in order to develop recommendations for regulatory proposals which might include:

> a) identifying and analysing differences that consider the current Canadian operational environment and;

b) suggesting alternate recommendations in respect to, for example, fatigue and the operational environment.

This might include the formation of sub-working groups.

OBJECTIVES AND GOALS

The Working Group will make recommendations in the form of a report to the Technical Committee regarding the FDT&RP and the FRMS scientific reviews, as well as the recommendations for regulatory changes resulting from the review and identification of commonalities and differences.

The Working Group will base its work on scientific data that is defensible and readily available. In addition, the Working Group will consider the work already completed by Transport Canada in regards to FRMS, as well as the regulations and proposals of ICAO and other States in an effort to adopt and harmonize regulations and best practices with those States, where appropriate.

STANDARDS BRANCH ROLE

The Standards Branch will provide funding for a scientific advisor, chosen by the Working Group, to offer technical support to the Working Group. Where the Group cannot reach agreement on the scientific advisor Transport Canada will nominate this person. This service will be provided within the constraints of the contracting policies and procedures of the Government of Canada. In addition, the Standards Branch will provide appropriate subject matter expertise to support the Working Group's activities.

The Standards Branch is responsible for administering and organizing the Working Group and for providing appropriate facilities and equipment for Working Group meetings.

SCOPE

The Working Group will:

- Review the existing FDT&RP requirements in the CARs, the ICAO fatigue management SARPS, regulations and best practices employed by other regulatory authorities.

- Review the FRMS NPA to CARs Part V, ICAO's proposed FRMS SARP, and other States' FRMS regulations, as well as other fatigue risk management methodologies, to determine the basic components of the FRMS.

- Review the FDT&RP requirements and the FRMS with reference to and utilising current scientific data relating to fatigue.

- Identify commonalities and differences with respect to the CARs relating to FDT&RP requirements and the FRMS approach to fatigue management, including the identification of differences in respect to, for example, fatigue and the operational environment.

- Develop a set of recommendations, in the form of a report, for fatigue management and the supporting rationale for the recommendation, with respect to FDT, rest periods, reserve duty, trans-meridian flights, and any other considerations deemed necessary by the Working Group and for FRMS. Dissents will be included in the report.

- Any other work deemed necessary to adequately complete the project.

DELIVERABLES

The Working Group leaders will provide a bilingual final report in hardcopy and electronic format that contains:

- A set of recommendations for fatigue management that includes the supporting rationale for each recommendation. Where consensus is not achieved on a recommendation the dissenting party shall provide a written dissent and supporting rationale, which will be appended to the report.

- The Working Group's review of the existing FDT&RP requirements in the CARs, the ICAO fatigue management SARPS and regulations and best practices employed by other regulatory authorities.

- The Working Group's review of the FRMS NPA to CARs Part V, ICAO's proposed FRMS SARP, and other States' FRMS regulations, as well as alternate fatigue risk management methodologies, to determine the basic components of the FRMS.

- The Working Group's review of the FDT&RP requirements and the FRMS with reference to and utilising current scientific data relating to fatigue.

- The Working Group's review of the commonalities and differences with respect to the CARs relating to FDT&RP requirements and the FRMS approach to fatigue management, including the identification of differences in respect to, for example, fatigue and the operational environment.

COSTS

Costs incurred with the Working Group members travel, accommodations, meals and incidental expenses shall be borne by their respective organizations. TCCA - Standards Branch will be responsible for providing meeting facilities and secretarial functions in addition to all necessary administrative support.

DURATION OF PROJECT

This Working Group will have 12 months from the date the Terms of Reference are signed to complete the project. After that time, the Working Group may continue if the Technical Committee agrees to the extension.

WORKING GROUP MEMBERSHIP

Transport Canada will co-chair the subject Working Group with a co-chair from the industry. The Working Group will be comprised of members from Transport Canada Civil Aviation Headquarters and the Regions, as well as industry stakeholders. Members should be prepared to actively participate in the Working Group.

The Working Group leader's first task will be to submit a work plan to the Director, Standards. The work plan will include all activities and related costs. In addition, the Working Group leaders shall submit progress reports after each meeting of the Working Group to the Executive Director of the Technical Committee and the Secretariat regarding progress made, decisions reached, updates on schedules, and issues that remain unresolved.

Working Group members may be requested to provide supporting data to justify recommendations and should have data available during meetings.
The Working Group will strive to reach consensus; however, when this cannot be achieved, the dissenting opinions will be recorded in the Working Group's final report and reviewed by the Technical Committee and forwarded on to the Canadian Aviation Regulatory Committee (CARC).

WORKING GROUP LEADERS:
Jacqueline Booth
Captain Dan Adamus

WORKING GROUP MEMBERS:

1. ACPA – Captain Doug Tweedlie, Air Canada Pilots Association.
2. ALPA – Captain Martin Gauthier, (Air Transat A-310)
   Chairman ALPA Canadian Flight-Time Duty-Time Committee.
3. ATAC - Captain Bill Boucher, VP Flight Operations, Air Transport Association of Canada.
4. Helicopter Association of Canada – Captain Fred Jones, President and CEO HAC.
5. Manitoba Aviation Council - Dennis Lyons, President, MAC.
6. NACC – Captain Michel Chiasson, (B767 Air Canada), National Airlines Council of Canada (NACC), Flight Operations Subcommittee.
7. NATA – Stephen Nourse, Executive Director with the Northern Air Transport Association.
8. CBAA – Art Laflamme, Special Advisor to the President and CEO, Canadian Business Aviation Association.

9. Transport Canada - Captain Mark Laurence, Senior Inspector, Standards Branch.
10. WJPA – Captain Daniel Glass, (B737NG) WestJet Pilots Association, Executive Member - Flight Safety.
11. Teamsters Canada - Phil Benson, Lobbyist Teamsters Canada.

_____

Don Sherritt, Director Standards

Date:

Appendix 4 – Curriculum Vitae - Gregory Lucas Belenky, M.D.

Research Professor & Director
Sleep and Performance Research Center
Washington State University Spokane
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Colonel, Medical Corps, U.S. Army (Retired)

Education

B.A. Psychology, Yale University, New Haven, CT 1966
M.D. Stanford University School of Medicine, Palo Alto, CA 1971

Research and Professional Experience

1966-1968	Research Assistant, Sleep Research Laboratory (Dr. William Dement), Stanford University School of Medicine, Stanford, CA
1971-1972	Intern (Internal Medicine), School of Medicine, University of Utah, Salt Lake City, UT
1972-1975	Resident (Psychiatry), School of Medicine, Yale University, New Haven, CT
1975-1984	Research Psychiatrist, Department of Medical Neurosciences, Division of Neuropsychiatry, Walter Reed Army Institute of Research (WRAIR), Washington, D.C.
1976-1978	Instructor, Department of Psychiatry, School of Medicine, Uniformed Services University of the Health Sciences (USUHS), Bethesda, MD
1977-2004	Emergency Service Psychiatrist (part-time), Woodburn Center for Community Mental Health, Annandale, VA
1978-1980	Assistant Professor, Department of Psychiatry, School of Medicine, USUHS, Bethesda, MD
1980-1996	Associate Professor, Department of Psychiatry, School of Medicine, USUHS, Bethesda, MD

1984-1995	Chief, Department of Behavioral Biology, Division of Neuropsychiatry, WRAIR, Washington, D.C.
Jan-Apr 1991	Chief, Mental Health Team, Medical Troop, Regimental Support Squadron, Second Armored Cavalry Regiment, Operation Desert Storm, Saudi Arabia, Kuwait, and Iraq
1995-2003	Director, Division of Neuropsychiatry, WRAIR
1996-2004	Professor, Department of Psychiatry, School of Medicine, USUHS
Jun-Aug 2003	Division Psychiatrist, Second Infantry Division, Camp Casey, South Korea
2003-2004	Director, Division of Neuroscience, WRAIR
2004-pres.	Research Professor and Director, Sleep and Performance Research Center, Washington State University Spokane

Military Service

1975-2004	Active Duty, U.S. Army; retired as a Colonel

Professional Organizations

American Psychiatric Association		
	Member	1975 - 1984
	Fellow	1984 - 2002
	Distinguished Fellow	2003 - present
American Academy of Sleep Medicine	Member	2000 - present
Sleep Research Society	Member	2000 - present
European Sleep Research Society	Member	2000 - present
Other Organizational Affiliations		
Sleep Disorders Research Advisory Board	Ex-Officio Member	1998 - 2004
National Heart, Lung & Blood Institute		
Board of Directors	Member	2000 - 2008
National Sleep Foundation		
Board Certification		
American Board of Psychiatry & Neurology	June 1978	

Medical Licenses

Commonwealth of Virginia # 0101030411
State of Washington # MD00047310

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Appendix 6 – Working Group Member Submissions Following Final Meeting

Appendix 7 – Working Group Member Comments/Dissents