NORMAL OPERATIONS SAFETY SURVEY

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Section 1. Purpose of NOSS

1.1 Executive Summary

The Normal Operations Safety Survey (NOSS) is a methodology for the collection of safety data during normal Air Traffic Management (ATM) operations. A normal ATM operation is defined as an operation during the course of which no accident, incident or event takes place of which the reporting and/or investigation are required under existing legislation or regulations. Training and check shifts are considered to be outside the scope of normal operations as they are evaluative in nature and controllers may not behave normally during such conditions.

NOSS is based on the Threat and Error Management (TEM) framework. TEM is a conceptual framework that assists in understanding, from an operational perspective, the interrelationship between safety and human performance as well as the dynamic and challenging operational contexts in which ATM is provided. TEM is a widely used framework in aviation and has been applied to accident investigations, incident investigation programs, licensing standards, and human factors training programs at numerous airlines and ANSPs.

By conducting a series of targeted observations over a specific period of time, and the subsequent analysis of the data thus obtained, facilities will be provided with an overview of the most pertinent threats, errors and undesired states that are specific to its particular operational context, as well as how those threats, errors and undesired states are managed by controllers. The information thus obtained will provide an ANSP the ability to proactively make safety changes in its operations without having to experience an incident or accident.

1.2 Purpose of NOSS

In theory, the ATM system is designed to function safely through the equipment the controllers are given to use, through the training that teaches them how to use the system and the procedures that provide guidance as to how to operate the system. In reality, the ATM system is full of complex, dynamic interactions and constant changes that cannot be fully anticipated in the system design stages. In short, NOSS is analogous to a 'health check' of operations – it provides information on how the ATM system *actually* is behaving as opposed to how it was *intended* to behave.

Traditional safety data collection programs are triggered by abnormal operations (i.e. data about situations that went wrong, or system/human performance failures). NOSS is process driven rather than outcome driven – data is collected during normal conditions to provide "safety intelligence" on system and human performance before a triggering event has occurred. NOSS allows ANSPs to monitor and understand normal operations, and develop proactive safety interventions prior to the occurrence of adverse outcomes. Further, since NOSS collects data during normal operations, it is likely to capture a class of safety information that is largely absent from event-based data – positive findings. Strengths can be identified both at unit level or the individual controller level. Effective procedures, adaptations, techniques, etc. can then be shared with others.

1.3 Rationale behind the development / deployment of NOSS

Conventional safety data collection programs mainly present data from abnormal operations (i.e. data about situations that went wrong, or system/human performance failures) and are outcome driven (i.e. some triggering event must occur in order for the event to be reported or for program to capture safety data). There are two major shortcomings to relying on event-based data to understand system performance. First, a negative event must occur before reporting or investigatory efforts are initiated. Second, most safety information is derived from the tiny percentage of operations during which abnormalities occur, meaning there is scant information available as to what is occurring in operations during the overwhelming majority of the time.

NOSS is process driven rather than outcome driven – data is collected during normal conditions to provide "safety intelligence" on system and human performance before a triggering event has occurred. In short, NOSS produces data and information about how the ATM system *actually* is performing as compared to how it was intended to perform. NOSS allows ANSPs to monitor and understand normal operations, and develop proactive safety interventions prior to the occurrence of adverse outcomes. Further, since NOSS collects data during normal operations, it is likely to capture a class of safety information that is largely absent from event-based data – positive findings. Strengths can be identified both at unit level or the individual controller level. Effective procedures, adaptations, techniques, etc. can then be spread to other units, controllers, etc. or incorporated into training, procedures, best practices, etc.

1.4 Relationship to the Safety Management System

Conventional safety data sources mainly provide information from abnormalities (incidents, failures, etc), and provide scant information on what is occurring in the absence of abnormalities. NOSS captures data about what is occurring in routine operations, and thus provides data about ATM system and human performance that is not otherwise available. As such, it complements the traditional sources of data for a safety management system (SMS). NOSS is regarded as a core component of an ATM SMS (i.e. it is an ICAO-endorsed method of fulfilling the requirement to monitor safety in normal operations).

1.5 Specific objectives of NOSS implementation

After conducting a NOSS, facilities will be able to set clear targets for safety enhancement of their operations. The effect of changes made can be "measured" by conducting a follow-up NOSS three to four years later. In the meantime the effect of changes may be noticeable by comparing specific trends from the pre- and post-NOSS periods.

1.6 Frequency of NOSS projects

NOSS is a periodic or cyclical program that is designed to be conducted every 3-4 years rather than on a continual basis. The primary reason for such a lag between NOSS projects is that some interventions, such as airspace re-design or specific training programs may take time to enact. If a follow-up NOSS were conducted too soon after an initial NOSS, it might not be possible to assess all change efforts that enacted as a result of the first NOSS. A secondary benefit of having periodic (as opposed to continuous) NOSSs (other than resources) is that the 'end-point' of delivering the

NOSS report serves as a catalyst to enact safety changes, rather than an endless process of data collection with no natural point for reaction to the data that has been accumulated.

1.7 International NOSS efforts

NOSS is supported and endorsed by ICAO and IFATCA. As of 2015, NOSS has been deployed by Australia, Canada, New Zealand, South Africa, South Korea, Thailand, the United Arab Emirates and the United States of America. Additional NOSS projects are being planned in Asia and Latin America.

Section 2. What sort of information does NOSS provide?

2.1 Threat and Error Management (TEM)

NOSS data collection is guided by, though not limited to TEM. TEM is a conceptual framework that aides, from an operational perspective, in understanding the interrelationship between safety, human performance and the dynamic and challenging contexts in which ATM duties are performed. TEM is a widely used framework in aviation and has been applied to accident investigations, incident investigation programs, licensing, and human factors training programs at numerous airlines and ANSPs. The TEM framework focuses simultaneously on the operational context and the manner in which controllers carry out their work within that context.

2.2 Summary level data with benchmarking

NOSS yields a mixture of quantitative and qualitative information to help understand what is occurring in daily operations.

The quantitative information obtained by NOSS yields summaries of various TEM metrics. These summaries can provide a "big picture" perspective on what is occurring in operations. When working with the NOSS Collaborative, these quantitative summaries will include de-identified comparisons with similar NOSS Collaborative facilities, which help when interpreting findings. Benchmarking can help identify potential areas of strength or vulnerability, and thus serve as reinforcement of operational strengths or as motivation to address possible vulnerabilities. For example, a particular sort of threat or error may be observed during 20% of observations. Benchmarking with other NOSS Archive facilities may indicate that 20% is very low (or high) relative to other facilities, which may affect the manner in which the ANSP interprets the result.

2.3 Descriptions of the operating environment and controller behavior

Quantitative data may help identify areas of strength or vulnerability, but it does not provide details as to *why* things are occurring. In addition to quantitative summaries of TEM metrics, NOSS provides rich descriptions of all the TEM-based events and other elements of interest that are occurring in operations. This contextual information provides details of the operational environment and how controllers perform their work duties within that environment. The combined quantitative and qualitative information provides a good indication of what is occurring in daily operations and provides a lot of information as to why things are occurring.

2.4 Vulnerabilities and "what is going right"

Unlike traditional sources of safety data collection which are triggered by abnormal events, NOSS data is collected during normal operations, prior to failures. This means that NOSS captures two distinct types of safety information – things that are going well and areas where improvements could be made. Potential vulnerabilities can be addressed before they lead to incidents, while strengths can be identified – at the unit-level or individual-level – so that they may be reinforced or spread to other units and controllers.

2.5 Uses of NOSS data

NOSS will provide a wide array of information, and most programs will provide substantial information on the following topics:

- *Proactive identification of vulnerabilities* – NOSS proactively or predictively identifies areas of vulnerability and provides an opportunity to make improvements prior to the occurrence of negative events. See All Case Studies in Section Three for examples.

- *Identification of strengths* – Most information pertaining to safety performance is derived from failures. But there is significant information to be gained from understanding the positives that are occurring in operations. The identification of strengths and positives can have several benefits. First, identifying and highlighting strengths can serve as positive reinforcement to controllers and management for a job well done. Second, identifying strengths can aid in the prioritization of safety initiatives – you don't need to focus on your strengths, merely reinforce and maintain them. Third, procedures or practices that work well at one facility may be useful at another facility. Finally, strategies and techniques deployed by some controllers may be useful to their colleagues. See Case Studies 3.2, 3.4 and 3.7 for examples.

- *Examine interactions with other ATM system actors* – NOSS is a systems based tool and provides information about interactions involving other ATM system actors, including adjacent ATM units, airspace users, military controllers, airport operators and other ground-based entities. NOSS provides insight to such interactions, but also objective data that can be used to help when attempting to enlist the aid of other parties in addressing safety issues. NOSS data has been shared with airlines to improve SIDs, de-conflict call signs, and raise communication standards. NOSS data has also been shared with airport operators to reduce and systemically manage runway crossings and to improve the signage / paint indications of confusing portions of the aerodrome. Case Study 3.8 provides just two of numerous instances in which NOSS data has helped to gain the assistance of other entities to address safety issues.

- *Converging lines of evidence and enhanced understanding of safety trends* – ANSPs have reported that many of the trends in their incident reports have been observed in NOSS. In several cases, however, NOSS has been able to provide additional information on the day-to-day practices (which were undetected by the investigation process) that were contributing to the incident trends. See Case Study 3.5 for examples.

- *Decision support tool* – Managers have reported NOSS has been useful to document issues they may already have been aware of through informal sources such as "gut feelings" or anecdotal reports from front-line controllers. By substantiating informal sources of information with hard data, managers have reported they are in a better position to justify their actions. For example, one ANSP had a large number of coordination breakdowns relative to other ANSPs. As a result, management made a concerted effort to try to reduce the amount of manual coordination that was required (through equipment acquisition and enhancing LOAs). Subsequent NOSSs revealed that coordination breakdowns were reduced by over 75%. Other examples include supporting the need to initiate airspace reviews/changes (see Case Study

3.1 for an example) and to install special lighting and noise reduction equipment in operations rooms.

- *Verification of the quality and usability of procedures and search for operational drift* – A NOSS provides feedback on procedures. Poor adherence rates can identify problematic procedures or procedural drift. For example, if a particular procedure is seldom violated, it may indicate an issue with a limited number of controllers or the particular circumstances in which the violation occurred. If, on the other hand, a procedure is violated with more frequency, it may be poorly understood or timed, may be a poor fit for the operating environment or signify procedural drift. See Case Studies 3.3, 3.5 and 3.9 for examples.

- *Understand controller shortcuts and workarounds* – As a result of experience, controllers develop shortcuts and workarounds to save time and work more efficiently. These shortcuts frequently involve contraventions of procedures, and are seldom seen during checks/audits, where performance is typically "by the book." Through a trusted process such as NOSS, it is possible to observe such shortcuts and workarounds. Some may be deemed effective and can be communicated to others within the organization as a "better way of doing things." Shortcuts and workarounds that have shortcomings in their safety assumptions can also be identified and addressed. See Case Studies 3.3, 3.5 and 3.9 for examples.

- *Feedback for training programs* – NOSS data can be used to improve training programs and to assess the extent to which training concepts have effectively been transferred to operations. First, NOSS data can be used to tailor training programs so topics reflect the issues that are both frequent and problematic in operations. Second, frequent or problematic threats can be worked in to training scenarios, thus making them more realistic. Finally, NOSS data can provide feedback as to how the material that is covered during training is enacted during operations. While simulator sessions and jeopardy evaluations can assess whether training concepts have been learned and controllers have the capability to perform their duties as trained, a NOSS can show the actual extent to which these practices are enacted in daily operations. See Case Studies 3.7 and 3.10 for examples.

- *Understand controller interactions with the equipment* – NOSS provides ample information on how controllers interact with equipment as they conduct their duties. Complications presented by the equipment can be documented as can controller adaptations in response to the equipment. See Case Studies 3.2, 3.3 and 3.5 for examples.

- *Prioritization of safety actions* – NOSS data can assist ANSPs to prioritize safety activities by highlighting the most prevalent and mismanaged threats, errors and undesired states in a particular operation. For example, NOSS data has been used to re-prioritize the (re)development of STARs and SIDs (airports where the observed impact was higher were moved to a higher priority status). Other applications include tailoring recurrent training to cover issues that local NOSS data indicated were problematic. See Case Study 3.7.

- *Benchmarking* – Benchmarking can help facilities interpret findings. Knowing the number of events (e.g. prevalence rates of various threats and errors and the extent to which they impact operations) is helpful, but knowing the number of events relative to similar facilities can help

interpret the numbers. The NOSS Collaborative, due to its strict quality control processes, is able to maintain an Archive of all the facilities where NOSS has been conducted. The NOSS Collaborative Archive contains data from more than 4,000 observations at facilities around the world, which allows for de-identified comparisons to be made between facilities. Benchmarking helped play a role in Case Studies 3.1, 3.2, 3.7, 3.8 and 3.10.

- *Collaboration with airlines* – More than 60 airlines in over 25 countries have deployed the flight operations equivalent of NOSS – the Line Operation Safety Audit (LOSA) – to inform their SMS. Some NOSS ANSPs and LOSA airlines have exchanged information of mutual interest from the NOSS/LOSA findings to enhance aviation safety. This exchange of information was aided by the fact that the airlines and ANSPs could produce objective data from common safety data collection strategies (LOSA/NOSS) speaking the same safety 'language' (i.e. TEM).

- *Engaged workforce* – NOSS is a highly visible and participatory process – data is collected and verified by peer controllers in a transparent manner. According to the experience of the NOSS Collaborative, this increases controller ownership of the process, and past NOSS observers have reported that it is not unusual for controllers to actively participate in finding solutions (often informally) to issues that were identified during the NOSS. Numerous observers have expressed that serving as an observer changes the way in which they operate when they return to working traffic.

- *Improved organizational trust* – The principles of NOSS encourage a collaborative approach. Several management and controller association leaders have reported general improvements in the larger safety culture which they partially attribute to NOSS. According to one national-level manager, "NOSS has the two-fold benefit of providing information that is consistent with the systems approach instead of a 'blame and train culture' and reinforces the commitment to this approach to those within the organization." The trust and collaboration required to conduct a NOSS can help reinforce the values of a Just Culture. According to Canadian Air Traffic Controllers Association President Greg Myles, "NOSS created the trust to pursue other projects such as the Just Culture Initiative at NAV CANADA."

Section 3. Case Studies

3.1 Identifying & reducing complexities

Issue identified during NOSS: A particular sector had an anecdotal reputation (amongst those who worked the airspace) as being unstructured and challenging, though there was little information available in the SMS to substantiate this reputation. NOSS data indicated that more threats, consequential threats, errors and undesired states were noted in this sector than in other airspace. This data, much of it collected by observers from outside the sector, substantiated the sector's reputation and provided some details on the complexities. Specifically, controllers spent a significant amount of time dealing with parachute operations, managing conflictions, and providing approach services to smaller airports, which often necessitated coordination with adjacent sectors due to a lack of airspace.

Response to findings: The NOSS findings prompted a review of the airspace, which led to several changes intended to simplify the airspace, including:

- The introduction of dedicated parachute jump areas, which allowed for parachute aircraft to be cleared into / out of the jump area instead of actively managed.
- The introduction of a circular flow structure to reduce conflictions.
- The expansion of the confines of the airspace to allow for more options/flexibility when working aircraft into smaller aerodromes near the sector boundaries.

Follow-up NOSS findings (three years later) showed a reduction of in the TEM metrics which were elevated during the initial NOSS. Anecdotal reports also indicated that the challenges presented by the airspace had improved.

3.2 Identifying strengths & improving weaknesses

Issue identified during NOSS: There were substantial issues pertaining to not knowing which aircraft were on frequency. Controllers were not issuing frequency transfers by the prescribed locations. Further, the fact that an aircraft had entered the sector but not established communications was often not being noticed until controllers attempted to issue instructions to the aircraft (sometimes to solve conflictions), who were still on the previous frequency.

NOSS observers, however, noted that some observed controllers were always quick to detect aircraft that had entered the sector but not checked in on frequency, and were never late in issuing frequency changes. The controllers who demonstrated high awareness of which aircraft were on frequency deployed individual techniques to indicate which aircraft were on their frequency (e.g. increasing the brightness of aircraft on their frequency, altering the appearance of the datablock).

Response to findings: The facility had transitioned from paper flight data progress strips, for which there was a method of indicating which aircraft had established communications, to electronic strips, for which there was no method. The NOSS observers proposed to management that controllers be required to use on of the techniques identified during the observations of controllers who demonstrated superior awareness of which aircraft were on frequency. It should be noted that a contemporaneous and highly publicized incident at another Enroute facility at this ANSP involved

an aircraft traveling through several sectors without establishing communications. The report by the Investigatory Body in this State highlighted similar deficiencies as the NOSS findings and made similar recommendations that had already been suggested by observers and adopted by management at the facility where NOSS had been conducted.

3.3 Enhancing barriers of defense / monitoring capabilities

Issue identified during NOSS: Aerodrome/Local controllers were not always conducting sufficient runways scans prior to issuing takeoff or landing clearances (nor were ground based radars being used to compensate). Several factors were also noted that were leading to increased "heads down" time by controllers. One involved the Aerodrome/Local controller interacting with the automation, particularly in sorting through long message queues, many of which were of no relevance to the controller (e.g. aircraft overflying the field at FL320). The other involved the hap-hazard manner in which the assistant distributed the flight data progress strips to the controller.

Response to findings: The organization made efforts to reduce the amount of "heads down" time by adjusting the strip distribution procedures and applying software filters to eliminate irrelevant messages in the automation. In addition, the importance of conducting proper runway scans were re-enforced by the quality standards and training teams. A follow-up NOSS indicated that runway scans were being sufficiently conducted (and even cited as a strength).

3.4 Transference of effective unit-level practices

NOSS findings #1: Many, but not all, ANSPs employ some sort of procedural countermeasure to ensure that critical information is passed during position relief briefings. At two NOSS Archive ACCs, the protocols and practices behind position relief briefings varied greatly amongst different work units within the Center. Some workgroups were deemed to have more effective briefings than others (e.g. the briefings were more structured and likely to include all relevant information, interruptions were better managed, and incoming controllers appeared more participatory in the briefings, etc).

Response to findings: The work groups that were deemed to have the more effective briefings utilized protocols that were unique within the ACCs to guide their briefings. One used a combination of a checklist and a "challenge-and-response" method in which the incoming controller guided the briefing, while another used an acronym. The protocols and practices in the work groups deemed to have effective position reliefs[1] served as models to the other workgroups, with many of the "best practices" being adopted at the behest of the observers who saw "a better way of doing things" when observing the workgroups that had good briefings.

NOSS findings #2 & Response: At several towers within a large ANSP, local procedures pertaining to a range of issues including VFR training flights, automation setup and helicopters using taxiways for takeoffs/landings varied. External observers (from other towers), noted that certain procedures, automation configurations, etc seemed particularly helpful and instigated their introduction at their home facility.

[1] Backed by a lack of incidents attributable to position reliefs in these work groups.

3.5 Augmenting & reinforcing incident data

NOSS findings: For several months, there were dramatic spikes and decreases in incidents pertaining to discrepancies of cleared altitudes and what was expected / coordinated with the next sector. The factors behind these incidents, and the reasons why they ebbed and flowed over a several month period was not understood. The NOSS data also detected differences in this group of sectors relative to other sectors at the facility. Specifically, there was a tendency amongst some controllers to "pre-load" the data block – changes were made to the altitude in the data block prior to instructions being issued to aircraft. This appeared to be the underlying behavioral practice that was leading to the incidents (and believed to be an adaptation to the high number of interactions required with the automated system).

Response to findings: Educational efforts were made to underscore the importance of coupling the act of issuing the altitude instruction (and receiving a correct readback) and making changes to the data block. These efforts were backed up by the supervisors and auditing regime.

3.6 Hazardous airspace and improper documentation

Issue identified during NOSS: Some general aviation and turbo-prop aircraft were filing departure routes through a piece of Special Use Airspace (SUA) which contained activity that could be extremely harmful to aircraft and its occupants. It was further identified that documentation available to pilots for flight planning purposes did not reflect the threat of this SUA. In all instances in which flights were planed through the SUA, controllers amended the routing so that the SUA was avoided.

Response to findings: While the controllers successfully detected and corrected all instances in which flights had planned through the SUA, it would be preferable to prevent events using more strategic measures so that the controllers do not have to "catch" such flight planning issues on a case-by-case basis. As such, the departures in question were immediately canceled via NOTAM and the documentation materials were updated to remove the departures in question.

3.7 Positive feedback & enhancing training

Issue identified during NOSS: NOSS findings at one major International Tower indicated systemic strengths during routine operations – despite encountering an elevated number of threats relative to comparable towers, such threats were significantly more likely to be managed successfully by controllers. Effective tactical countermeasures were being consistently used to account for aerodrome limitations and to the capture threats posed by pilots. However, threats stemming from non-routine traffic (survey flights, MEDEVACs, etc) were leading to controller errors and undesired states.

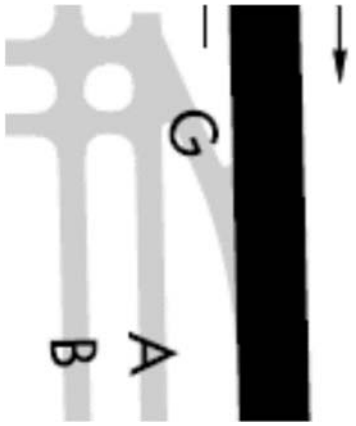
Response to (positive) findings: The data collected during routine operations indicated robust training and procedures and were indicative of a high standard of performance. These findings were distributed to staff and managers to vigorously reinforce the high standards demanded by and practiced at the unit (i.e. "this is how we do things at XX Tower").

Response to findings (non-routine traffic): Management took a multi-faceted approach to address the vulnerabilities surrounding non-routine traffic:

- **Endorsement training:** The materials used for initial endorsement training have been updated to include a greater emphasis on non-routine operations. It is believed this will better prepare trainees for complexities of working real-life traffic, better enable them to handle such traffic and thus reduce the amount of time required to qualify controllers.
- **Simulator training:** Non-routine operations are being incorporated into simulator training. This makes the training more realistic and tailors it towards the aspects of operations that are problematic. It should be noted that other facilities are also working common or problematic threats into their simulator training with the aim to making such training more realistic and effective.
- **Increased supervisory oversight:** The presence of non-routine traffic is being used as a "trigger" for the shift manager to provide increased oversight and assistance in implementing tactical traffic management strategies to cope with the non-routine traffic.
- **Prior identification of non-route traffic:** Scheduled non-routine operations (e.g. airwork, survey flights) are required to notify the shift manager of their intended operation prior to departure. This allows for the controllers to have advanced knowledge of such operations, thus minimizing their impact and allowing for the implementation of tactical traffic management strategies.

3.8 Identifying aerodrome & airspace limitations

Issue #1 identified during NOSS: During several observations in a tower, arriving aircraft were observed to slow significantly (even coming to a complete stop) as they exited the runway via the rapid exit taxiway (see below). Discussions during data verification indicated that controllers were familiar with several instances of aircraft turning on to the wrong taxiway at this intersection, though these events did not appear to have been reported. The impression amongst controllers was that this was a confusing intersection that was contributed to pilot taxi errors and increased runway occupancy (as aircraft were slow to vacate the RET).



Response to findings: Management presented the findings to the Airport Operator, who painted additional markings on the taxiways to more clearly indicate the taxiways.

Issue #2 identified during NOSS: A single, bi-directional airway was being used for all North-South traffic in a major metropolitan area. To compensate for the lack of built-in lateral separation, off-set procedures were sometimes (but not always) utilized. NOSS observations indicated that the utilization of the off-set procedure significantly increased the controller's workload by increasing their communication and strip marking responsibilities. Further, mistakes were sometimes made by controllers and pilots in their application of the off-set procedure, thus negating the benefits of the procedural countermeasure.

Response to findings: Management used the NOSS findings along with other information to build a case for the development of parallel, segregated airways to systemically separate northbound and southbound flights. The comprehensive case presented by management convinced the military (who owned the adjoining airspace) to provide enough space for the development of parallel, segregated routes. A follow-up NOSS showed this portion of the airspace to be considerably less complex.

3.9 Understanding controller shortcuts and workarounds

Issue #1 identified during NOSS: Departing aircraft were being given headings by the local/aerodrome controller without coordinating with the terminal controller (in contravention of local procedures) during about half of the observations. The rest of the time, headings were being coordinated.

Response to findings: Focus group discussions indicated that the headings being issued by the local/aerodrome controller presented no operational concern to the terminal controller. In fact, the coordination of such headings was deemed "nuisance coordination" by the terminal controller. In response, a Letter of Agreement (LOA) was drafted that permitted the issuance of certain headings by the local/aerodrome controller without coordination being required. This change to procedures reduced coordination and ensured that the procedural guidance is closely aligned with operational realties, thus providing more credibility to the procedures that remained "in the book."

3.10 Pilot / Controller Communications – Setting the standard

Context: Anecdotal reports indicated that two similar sector groups within the same ACC had drastically different standards of communication practices. Specifically, Group A was believed to adhere to prescribed communication standards, while Group B was reputed to employ more slack standards (i.e. they were the "cowboys").

NOSS findings: The anecdotal reports were confirmed – far more communication errors were noted in Group B (non-standard phraseology, call sign truncation, readback/hearback errors) than in Group A. Interestingly, however, significantly more communication threats (incomplete readbacks, call sign omission / truncation & non-standard phraseology) were observed from pilots operating in Group B, despite the fact that the same operators and often the same flights were operating in both Groups. The observers from both Groups were surprised that the communication standards employed by the *same* pilots were of a high standard while operating in Group A and decidedly lower while operating in Group B.

Discussion & Response to findings: Given that the same pilots employed different communication standards in the two Groups, it was concluded that controllers were setting the tone for acceptable practices. Group A controllers used standard phraseology, full call signs and challenged many of the incomplete readbacks that did occur. It was believed that this high standard of communication practices set the tone for pilots – having heard the controller use crisp phraseology and challenge incomplete readbacks, pilots employed better communication practices. Conversely, Group B controllers set a lower standard of communication practices, which in turn elicited a lower standard from pilots. The implication of this finding is that one way to improve pilot communication standards is for controllers to set the tone by employing a high standard and to challenge incomplete readbacks.

Section 4. NOSS: Why a systems-based tool?

4.1 Evolution in Safety Thinking

The General trend in safety thinking (inside and outside of aviation) is evolving to a systems perspective. The 1980's and 1990's saw a focus on human performance and the development of interventions such as Crew Resource Management (CRM) and Team Resource Management (TRM). At this time, airlines started to ask how pilots were deploying CRM behaviors on the flightdeck. To answer this question, the University of Texas, in collaboration with a number of international airlines developed a set of behavioral markers to measure pilot behavior on the flight deck. While the behavioral markers produced useful information on human performance, additional observational experience made clear that human performance did not occur in a vacuum; it occurred in a complex, dynamic environment.

Human performance is obviously a critical element of safe operations (and is captured in NOSS though threat management, errors and error management), but safety thinking has evolved to a more systems-based perspective as human performance does not occur within a vacuum. Performance is impacted by the operational context, which is affected by multiple components/elements (other controllers, other FIRs, airspace users, airspace design, equipment, meteorological conditions, ground operators, etc,) and their interactions. Adopting a systems perspective allows for a greater understanding of the operating context. It is critical to capture the operational context when collecting safety data as managers spend as much time trying to understand and manage that context as they do individual human performance. Further, a greater understanding of the operational context will aid in understanding, and thus shaping, human performance.

4.2 Managing humans or managing systems?

A manager manages threats as much as they manage human performance (errors) Improving human performance may often best be achieved by trying to optimize the operational context in which controllers discharge their duties. The human performance lens, while very important, is a pretty narrow perspective to take when trying to optimize the operating context. Human performance after all – whether positive or negative – is often an adaptation or symptom attributable to the context in which they are operating. A systems-based tool opens up more layers of defense to intervention

4.3 A systems approach allows for more level of intervention

Human performance based tools are heavily tilted towards training interventions and Quality Assurance/Quality Control regimes (and perhaps procedural adaptations to a lesser extent). NOSS data has been applied extensively along those avenues as well. But systems-based data opens up additional "layers of defense" for intervention. This gives managers more tools to make improvements and thus place controllers in a better position to discharge their duties. NOSS findings lead to airspace changes, equipment changes/adaptations, supervisory changes, and exchanges with other units and airspace users as often as training interventions, procedural adaptions, the adoption and dissemination of new 'best practices' and enhanced QA/QC efforts. A

narrower focus on human performance (like in D2D, see next section) would likely see less breadth in the interventions that can be undertaken to enhance system safety.

Section 5. Differentiating between NOSS and NATS 'Day-2-Day'

5.1 The Fundamental difference between NOSS and D2D

NOSS and D2D are both useful observational methodologies to gather data during normal operations, but their focus and philosophies are very different:

- NOSS adopts a systems perspective
- D2D takes a human performance approach.

These core differences, more than any other factor, would likely determine which tool would be the best fit for an organization.

5.2 Narratives vs. Ratings

NOSS observers take shorthand notes during the observation and then enter their observations into a systematic data collection instrument after the observation. It should be stressed that the observer's task is not to rate or evaluate what they saw – merely to objectively describe pertinent events as taught in the observer training course. TEM is then applied to these context rich descriptions.

D2D utilizes a set of human performance markers (along the lines of the behavioral countermeasures deployed by the University of Texas in the pre LOSA/NOSS days) which requires observers to rate controllers.

Section 2.1 described the evolution of a focus on behavioral markers to LOSA/NOSS. Contributing to this evolution, was the realization that behavioral markers are bounded by the markers in which in which raters were asked to judge. Such a closed ended observational system is not ideal to capture complex, dynamic systems-based data.

In contrast, LOSA/NOSS observations are based on rich narratives backed (but not fully based) on the TEM framework. These narratives allow for rich contextual information to be captured and are more sensitive to unanticipated interactions than are pre-determined ratings forms where there is much more of a risk that observers only capture the countermeasures they're given to rate. The rich narratives produced by NOSS are one of its biggest strengths in capturing the context of a complex, dynamic nature in everyday air traffic operations.

5.3 The post-observation interview

D2D utilizes a post-observation interview session with the observed controller to clarify what was observed while NOSS maintains, to the maximal extent possible, an unobtrusive approach and does not utilize a post-observation interview. The ICAO NOSS Study Group consciously decided against utilizing post-observation interviews for several reasons. The primary reason was concern that introducing an interview or debrief of what was observed affect the behaviors controllers

demonstrate during the observation. Specifically, controllers may display more “Angel Behavior” as opposed to “Normal Behavior,” which would adversely impact the quality of the data collected.

NOSS makes great efforts to ensure that controllers are as comfortable as possible with the process (see the 10 characteristics in ICAO Document 9910) as possible to ensure that we are able to observe “Normal Behavior” to the maximal extent possible. Therefore, it was decided that the potential benefit gained from interviews would be outweighed by potentially pushing controllers more towards the “Angel Behavior” of the spectrum. Additionally, it should be remembered that the task of the NOSS observer is to provide an objective description of what was observed – not to rate or evaluate the observed controller. As such, much of the insight gained in D2D from the interviews can be gained in NOSS using the descriptions provided by observers during other phases of the process such as data verification.

A secondary reason for electing not to have interviews is that the focus of NOSS observations is an operating position, and not an individual controller. Therefore, observations often continue when a position change occurs. Finally, NOSS adopts the perspective that we are happy to have the privilege to observe controllers while they are working, and we do not want to bother them with an interview as they leave their position to go on break (though NOSS observers are happy to receive any thoughts/perspective freely provided by the observed controller and record them in a special section of the data collection instrument).

5.4 Summary of differences between NOSS and D2D

	NOSS	D2D
Description	Safety Management tool for data collection on systemic safety performance in ATM	Tool for evaluating human performance in ATM
Theoretical basis	Threat and Error Management (TEM) framework	Behavioral markers set
Project duration	Defined period of time	Continuous
Interview with observed ATCOs	No	Yes
Observer reporting	Objective	Subjective
Endorsement by ICAO	Yes	No
Airline equivalent	LOSA	n/a

Section 6. NOSS Endorsements

6.1 ICAO

NOSS was developed as an ICAO sponsored activity with the support of IFATCA and numerous ANSPs. NOSS is an ICAO-endorsed best practice for the collection of safety data during normal ATM operations. As such, ICAO has produced guidance material on NOSS (ICAO Document 9910) and TEM (Circular 314).

6.2 Air Navigation Service Providers

NAVCANADA

We already have a number of well-established processes to capture safety related Operational data. Each process is designed to capture a particular aspect of the operation. For example, we have:

- Event reporting: which consists of a mandatory reporting system (AOR), and confidential safety reporting system (Argus)
- Investigations: including preliminary investigations conducted by the site, followed by independent investigations conducted by the safety group.
- Unit Audits: these are regularly scheduled audits of the operational and administrative aspects of a unit.
- SMS Assessments: this process evaluates the overall performance of our Safety Management System (SMS), i.e. the degree to which the goal of the SMS is being achieved.
- Safety reviews: which are employed to determine whether risks related to current or planned operations are being managed effectively, and
- Hazard Identification and Risk Analyses: which are a key aspect of the risk management process applied prior to the introduction of changes to the Operation.

NOSS complements these existing processes.

One of the key benefits of NOSS is Risk Management, specifically the proactive identification of hazards and risks. NOSS is a data collection tool during Normal Operations; therefore there is no triggering event to initiate the NOSS process. The language of Threat and Error Management is aimed at front line personnel, however the findings translate into risk management information, and senior management can use the findings to help prioritize safety management activity. It helps us to answer the question of “Where do we need to focus our efforts?”

Because NOSS is different from each of our other safety data collection tools (e.g. Unit Audits, Investigations, Safety Reviews), it provides an excellent opportunity to identify “converging lines of evidence” – if we see similar issues using different methodologies it provides a higher level of confidence for assessing the risk level.

NOSS also identifies areas where Threats are being well-managed; thereby allowing the organization to know what is working well.

Many of the benefits of NOSS derive from the 10 Principles of NOSS- the principle of “Joint Management/controller association endorsement”, “Voluntary participation” of the controllers being observed, and having a “trusted data collection site” have contributed to the strong trust in the NOSS process at NAV CANADA.

NOSS fosters a positive safety culture through an engaged workforce. Again, the voluntary participation, the peers observing peers, and the involvement of controllers in data collection, data cleaning, and providing feedback to other controllers have led to strong engagement of the workforce. This engagement continued into the change management processes, where controllers were very interested in getting involved in the mitigation of the issues.

Additional benefits:

- NOSS fosters cooperation with the regulator (Transport Canada)
- NOSS demonstrates organization’s safety commitment and SMS maturity
- Threat and Error framework allows for easier exchange of safety issues with customers who are applying LOSA, and with other air traffic service providers who are applying NOSS. We’ve had excellent exchanges with air operators.

In summary NOSS provides:

- Rich source of data
- Impetus for discussion and enhancement
- Individual and organizational awareness/learning

Ann Lindeis, PhD
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NAVCANADA

AIRWAYS NEW ZEALAND

The NOSS program has been very successful for Airways and it is now a respected, regular and useful process used within our organisation.

Airways New Zealand has been involved in the development and implementation of NOSS from the outset. Since NOSS was made a recommended practice by ICAO, Airways has run three full NOSS surveys of our radar facilities and major towers.

NOSS has provided us with a wealth of scientifically valid data that has significantly contributed to building a coal face level picture of what is occurring in our operational environment and, more importantly, what the root causes of events are based on a structured methodology i.e. Threat and Error Management. This was a significant step forward for us as existing data sources gave limited insight into the root causes behind events.

NOSS has been extremely well received by our people as it provides outputs they directly relate to and the process is largely driven by peers who they respect. Additionally, the process provided additional security for our people as it was endorsed and supported by the organisation and the controller's union.

Running the NOSS observations is only half the process and it is how the data is used to generate meaningful change that is the most important element. Airways has used the outputs from NOSS to target specific areas for improvement e.g. raising standards of inter sector co-ordination and improving RTF performance across the organisation.

The pleasing outcome is that successive NOSS surveys have indicated significant improvements in areas that were targeted through improvement programs. In addition to specific campaigns, NOSS data has been used for a more generic safety improvement program called PULSE (Professionals Us Leading Safety, Everywhere). This program was staff lead and based on the principle of defining professional standards and attributes and increasing Human Factors knowledge. This program generated a very significant improvement in safety performance outcomes in our service delivery area.

Paul Fallow
Main Trunk Manager
Airways New Zealand

Section 7. Glossary

- Threat and Error Management (TEM): A conceptual framework that assists in understanding, from an operational perspective, the interrelationship between safety and human performance in dynamic and challenging operational contexts.
- Threats: Events or errors that occur beyond the influence of the air traffic controller, increase operational complexity, and which must be managed to maintain the margins of safety
- Errors: Actions or inactions by the air traffic controller that lead to deviations from organisational or controller intentions or expectations
- Undesired States: Operational conditions where an unintended traffic situation results in a reduction in margins of safety
- NOSS: Normal Operations Safety Survey
- LOSA: Line Operations Safety Audit – the flight operations equivalent of NOSS which has been deployed by more than 60 airlines in over 25 countries
- D2D: Day-to-day - methodology developed by NATS (UK) for continuous monitoring human performance in ATM operations.