

9.0 MRM: IT CAN'T BE CRM RE-PACKAGED.

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INTRODUCTION

This paper makes these major points: (1) [CRM](#) training is neither an effective nor an appropriate paradigm for use in developing [MRM](#) training; (2) MRM development and delivery is repeating mistakes that early CRM made; and (3) to develop quality MRM training, we must face and deal with the basic issues and questions that - as yet - it has ignored or avoided. The rationale and the impetus for the current direction of MRM training will be stated. We will look at CRM, past and present. The basic components of CRM and its delivery model will be examined as they relate - or, do not relate - to the development of MRM training. Finally, a series of recommendations will be offered as to what the maintenance community, to include [AMTs](#), can and must do to re-direct and re-develop quality MRM.

MRM FROM CRM?

A historic conference was held in Washington, DC in early 1995. This conference had over 900 top-level representatives from the Aviation Industry, Labor and the Federal Government. [DOT/FAA](#) published, in February of 1995, a seminal document based on the efforts of 6 major work groups at that conference: *Zero Accidents...A Shared Responsibility*.¹ Later in 1995, a follow-on meeting was held in New Orleans and another document, larger and more detailed, was developed. This document, *DOT/FAA Aviation Safety Plan*, provided instructions on how to accomplish the initiatives set forth in *Zero Accidents*.^{2,1} The *Aviation Safety Plan* also provided a matrix for each initiative so that progress on each initiative could be easily charted and followed.²

In the section on maintenance and inspection of *Zero Accidents*, a facile assumption was made that the new training seen as necessary for reducing [AMT](#) error was to use [CRM](#) as a model.¹ This new training called [MRM](#) was to be based on existing CRM. This assumption quickly achieved the status of a fact, became almost a mantra and was not questioned -- rather, it was acted on.

In doing so, the basic issues and questions that must be faced and answered in developing quality training were, seemingly, fluffed off. This naive acceptance of what has increasingly proven to be an incorrect assumption has put [MRM](#) at risk -- at risk of going down some of the same garden paths of early [CRM](#); at risk of being ineffective; at risk of failure.

It seems some [MRM](#) has taken some of the worst of early and middle [CRM](#). It is true that some (most?) current MRM has a case of "the emperor has no clothes." By this, it is meant it has no basis, no foundational rationale, no clear and measurable performance objectives and no one seems willing to publicly say this. Until now.

A Chilling Experience at 35,000 Feet

I first had some of these thoughts, and fears, on a flight from [DFW](#) to [PHL](#). As I sketched them out, I wondered if they were the product of too many long flights; too much airline food; or simply too much travel where you sometimes get into a Twilight Zone, which blurs reality and fantasy. One antidote was to make a reality-check call to an old friend and colleague. This person is a former [NTSB](#) accident investigator who fought for a human factors component in aviation accident investigations, a former [FAA](#) scientist who worked on [CRM](#) and decision making for pilots, a former chief scientist at the [USAF](#) Safety Center, who championed CRM and, in his earlier life, a maintenance chief and mechanic in the USAF. So, I called Dr. "X" (more than once) and we spent quite a bit of time kicking my thoughts and fears around. I then spoke to a CRM expert, now in maintenance/safety at a major aircarrier; to a trainer for a major flight training company; and 3 or 4 others with experience and expertise. We agreed that "MRM ain't CRM." One result of these talks is this paper.

Closer look at CRM

History & Problems:

[CRM](#), in some form, has been with us since the very late 1970's. By 1997, CRM is an integral part of aircrew training used by the carriers, is mandated by the [FAA](#) ([SFAR](#) 58 and the 1996 changes in [CFR](#)14, Part 121) and the [USAF](#) (Air Force Instruction 36-2243). The tendency is to view CRM in terms of the status and success that it has achieved over the past 6 to 8 years. But, we also tend to forget or ignore some of both the early and current problems of CRM training. It is no secret that some of the early CRM training was far from an unqualified success. This was due both to some of the people who were allowed to develop and deliver it and to some of the course content. There were misguided and inappropriate course materials; some courses that were completely focused on "soft" skills; the view of aircrews that CRM was only a "charm school" or only a box to be checked to appease the company they worked for and/or the FAA; the "crow like a rooster" exercises used by some former sensitivity trainers, T-Group leaders and re-tread management trainers trying to stake a claim to CRM training. Early CRM training became a target of opportunity for these former trainers; for psychologists looking for a second career; for people who had peripheral, if any, experience and expertise in flight operations. A cottage industry of CRM trainers and training arose.

What followed was not unexpected. Pilots asked how this "soft stuff" could help them in the cockpit. Flightcrew saw little relationship between the course and "flying the line." Further, many gave no credibility or credence to some of the people who delivered [CRM](#), people whom the airline pilots said did not have the flight deck credentials to instruct them in being a better crew. These were the two key issues: the lack of credibility for some of those delivering the courses, and, by extension, those who developed the courses and the course content itself. Not until CRM developers faced and resolved these valid concerns did CRM begin to take hold.

One major change was that many major air carriers soon involved their pilots as the prime movers in both course content and course delivery. Additionally, true [CRM](#) experts and some of the CRM instructors at the air carriers had united to begin addressing these vital issues: (1) What are the crew performance indicators, on a [LOFT](#) scenario (a realistic flight from point A to B to be flown in the simulator) that showed CRM skills? (2) What event-sets do you build into the LOFT scenario, or a check-ride, that gave the crew the opportunity to demonstrate that CRM training had an effect on their crew/individual performance? (3) How do you best develop CRM scenarios? Again, what crew and individual performances and decisions do you look for? and (4) What are the relationships between CRM trained skills and resulting flight control and safety skills and actions?

As [CRM](#) training began to shift its focus to the integration of CRM skills with flight control skills, as CRM focused on [LOFT](#) scenarios as the place where CRM skills could be observed and assessed, CRM began to achieve real acceptance in the pilot community. CRM development and LOFT development became interrelated at carriers; in [ATA](#) work groups and in [FAA](#) reports. When CRM was flightcrew-developed and taught, and had a much more specific content, i.e., content that was centered around real problems with "flying the line," then CRM gained a measure of acceptance. However, even that acceptance is not as unequivocal as it once appeared.

American Airlines, in July of 1996, set aside [CRM](#) as they were doing it. Their reason was that their flightcrews had valid objections to, and concerns about, CRM. "CRM was too often viewed as a number of interpersonal issues that simply do not define the problems that we face in aviation."; " CRM training will most likely always be defined and suffer in terms of the first generation of courses.".. which were seen as "touchy-feely," "getting along," and "managing human relations or resolving personality conflicts" rather than dealing with truly important concerns.⁴ American's new focus will be on preparing flightcrews for the daily challenges of normal and abnormal operations encountered "flying the line." Delta Air Lines, in the same time-frame, has revamped their CRM for New Captains' course and are calling it "In Command." As with American, Delta is emphasizing leadership, responsibility and performance. In 1996, we see these two major carriers eschewing the "I'm ok, you're ok" thrust of some CRM. United's version of CRM was, and is, called C-L-R, where the C is for Command and the L is Leadership, so it seems that United has already gone past the "touchy-feely" aspects of CRM and on to the performance issues. Yet, even United is changing aspects of CRM for 1997.

In sum, [CRM](#) has recently undergone several changes at three major carriers. It seems CRM was neither the silver bullet nor as universally accepted as we thought. All too many of the CRM "lessons learned" are being overlooked by [MRM](#). Much of the MRM that is being developed and given is focused on exactly what CRM is abandoning as ineffective, non-productive and poorly received by the target audience

CRM Components: The Three Basic Clusters and Their Categories

Communication Process and Decision Behavior Cluster

(Categories)

Briefings/Debriefings

Inquiry/Assertion

Crew Self/Critique

Conflict Resolution

Decisions

Communication

Team Building and Maintenance Cluster

(Categories)

Leadership/Followership

Focus on Tasks/Focus on Operations

Interpersonal and Group Climate

Automation

Work Load Management and Situation Awareness Cluster

(Categories)

Planning-Preparation-Vigilance

Workload Distribution

Distractions and other Avoidance

Behavioral Performance Markers

The categories within the clusters are further subdivided into behavioral/performance markers. These markers can be used as performance identification assessment tools. Each category has as many as eight performance markers ([Appendix](#)).

Decision-Making (DM) and Situation Awareness (SA)

At this time, DM and SA have become, (always were?), separate entities. There are conflicting views as to whether [CRM](#) encompasses aeronautical decision making (ADM) and SA or, whether ADM encompasses CRM and SA and so on. However, the bottom line is that good people are working these areas and there is a host of data, reports, [R&D](#), articles and books on them that should be consulted and used as appropriate.

The CRM Three Phase Training Model: Initial Indoctrination; Operational; Recurrent

1. Initial Indoctrination/Awareness Phase: 4 to 16 hours. This introduces [CRM](#), the history and rationale for its development, often uses one or two accidents where poor coordination or communication cost a hull and lives, and/or one where CRM is seen as saving lives (e.g., United 232).

2. Operational Phase: 2 to 3 days. The emphasis is on crew performance: the learning of [CRM](#) skills with the demonstration and the practice of these skills in a full-up flight simulator, by means of a [LOFT](#) scenario -- which is taped, with a playback/feedback/critique session afterwards.

NOTE: The first and second phases can be, and often are, rolled into one 3 to 4 1/2 day session.

3. Operational Reinforcement: Usually, this is formally done in Recurrent training as yearly Recurrent training is mandatory for flightcrew. This phase takes into account that [CRM](#) skills decay over time. Therefore, (some) CRM training is often incorporated into Recurrent and, at some carriers, in seminars, practice sessions, "batting practices," etc.

NOTE: This model has evolved since 1978 or so; it still is evolving. This model may not exactly "fit" the CRM training of any given carrier, but, it should be fairly close. Further, changes in Part 121 have made [CRM](#) mandatory in any [AQP](#) program.

CRM and MRM: Similarities, Differences and Recommendations:

Before we look at the components of [CRM](#) to see how either they differ from, or are similar to, what [MRM](#) needs to encompass and, before we consider how best to use these CRM similarities, a few large, generic and significant differences between CRM and MRM need to be spelled out.

The Audience: Aircarrier crew usually have a fairly uniform level of college education, often have military training and flying experience; have a highly-prized license, the [ATP](#), and are over 30 years old. They are a group which has a pride of accomplishment in what they are and do; see themselves as very special, highly trained and highly professional; and, the pilot group is "closed" to non-pilots.

The Team: While the flight crew is a team, even if an ever-changing team, the [CRM](#) training given them on team functioning is applicable on every leg they fly. Most [AMTs](#) do not work in formally organized and structured teams even if some carriers and companies are trying to change this.

The Environment and "Climate": While Part 121/135 and corporate flightcrew usually belong to a union of sorts ([ALPA](#) or [APA](#)), most [AMTs](#) belong to a more typical union ([IAM](#)). A unionized workplace in terms of restraints and constraints on what can be done for and with the workforce, must be factored into any [MRM](#) training development and delivery.

Assessing Learning and Skills: Another major difference between [MRM](#) and [CRM](#) is that there is no maintenance equivalent of a flight simulator or [LOFT](#) scenarios. There is currently no place where a realistic (but safe) hands-on assessment of what an [AMT](#) has learned in MRM can be done, an assessment that demonstrates whether or not an AMT has both learned new MRM skills and applies them "on the job." This may be changing as CAE now says that it has a maintenance training simulator.

FAA Regulations: Flightcrew training requirements and performance assessment are highly regulated. There have been very recent changes to [FAR](#) 121.427;.406;.421 that mandate [CRM](#) especially in any Advanced Qualification Program (AQP). Additionally, CRM training is usually given during the mandated yearly recurrent training at the major carriers.

In Sum: The [CRM](#) audience is extremely homogenous; they perform the same function of flying (revenue) passengers from point A to B; they have extremely similar educational and experiential backgrounds and most vital, they are legally "in charge" and responsible when they are on the flight deck. The CRM skills they learn can be assessed in [LOFT](#) scenarios with no danger to an aircraft or crew. Finally, changes to 14 [CFR](#), Part 121 mandates CRM training.

Very little of the above is true of an [MRM](#) audience. [AMTs](#) do very varied tasks, from engine overhaul to micro-chip replacement on a flight management computer. AMTs have differing levels of education and their prior experiences can range from the proverbial "mom and pop shop" to a Part 121 carrier. Maintenance simulator environment is being developed but does not now exist at the major carriers. AMTs do not have Federal Regulations which make them the ultimate decision-maker. However, they are responsible, ("on the blame-line"), for their actions. MRM training is not now mandated by the [FAA](#).

Major "Components" of CRM and Differences from CRM; Applicability to developing MRM

CRM

1. Communication

CRM is based on a 2/3 person cockpit crew plus the cabin crew and now, at some carriers, dispatch. These people are together 2 to 14/15 days at a clip. The cockpit crew works off [SOPS](#)/check lists/manuals. The focus of this component of CRM is the pre-flight briefing; crew inquiry-advocacy-assertion of courses of action; the crew self-critique at debriefing; free and open communication; conflict resolution.

MRM

At this time, few if any, carriers have implemented a team concept. The structure of a flight crew versus a maintenance crew has some similarities, except for the authority and responsibility of the Captain. The concepts of inquiry and free and open communication are a "must" in any functional organization.

Recommendations: Develop [MRM](#) communication modules based on tested communication concepts (active listening as a major example). Blend in a focus on the types of communication, especially in the areas of conveying the results of trouble-shooting, that [AMT](#)s/foreman have. In-house development of this module would best be done by an in-house team, in a very structured workshop. The team should be composed of [AMT](#)s, foremen, middle-level and upper management, plus one [CRM](#) expert and one non-company expert in facilitation.

CRM

2. Decision-Making (DM)

The decisions of a flightcrew are usually time-compressed; only involve 2/3 persons; have immediate consequences. There has been shown to be a specific process/typology for Aeronautical Decision Making (ADM).[9,10](#) **NOTE:** This should be a separate module.

MRM

The process for making decisions by an [AMT](#), or an [AMT](#) crew, ordinarily are just the opposite as those of the flightcrew. However, studies of decision-making on the job (naturalistic DM) show that each profession develops a unique DM style; one that can be analyzed, taught and enhanced.

Recommendations: Use known experts in decision-making, especially those in naturalistic, team [DM](#), to develop the typology, process and training for [AMT DM](#).[7](#)

Coordinate this effort with an across industry structured workshop to incorporate the best of [ADM/CRM](#) and the requirements of industry for [AMT/DM](#). Let the workshop findings feed into what the experts developed above.

CRM

3. Situation Awareness

This SA needed by a flight crew invokes an ever changing, and quickly changing, environment where loss of SA has the possibility of quickly leading to disaster.

MRM

There is little analogy in maintenance to the situation awareness needed by a flightcrew. However, just as the SA experts on the flight side have developed the concept-components-process-training for flight crew SA, it is reasonable to expect that the same thing could be done for maintenance SA.

Recommendations: Basically, the same as for [DM](#). It may well be that the Situation Awareness (SA) required in the maintenance environment by an [AMT](#) or an [AMT](#) crew varies greatly from a flightcrew's SA. "Attentional Awareness" seems more appropriate to the maintenance environment. There has been work done in this area that can apply to developing analogous [MRM](#) training.

CRM

4. Workload Management

CRM emphasizes managing workload and time to maximize crew efficiency; distributing the workload to maximize efficiency, and clearly communicating this distribution; active monitoring and vigilance (weather, systems, ATC, instruments) and clearly sharing relevant information with other crew members; planning and preparation, and finally recognizing and avoiding distractions.

MRM

This would seem to be one CRM area that holds real promise for MRM. What should be emphasized here is shift work; changeover; fatigue.

Recommendations: Develop an MRM workload training module. In this module, use must be made of the many studies on workload; on shift work; on fatigue. Develop the MRM workload training module (at least the requirements and content areas for this MRM component) through a process which invokes and makes full use of the experts in CRM in management, in fatigue, and in shift work.

CRM

5. Team Building and Maintaining the Team

This cluster emphasizes leadership/ followership, concern for tasks, interpersonal relationships and group climate.

MRM

This CRM component has great potential for developing MRM analogs. But, we must be aware of the differences between flightcrew and maintenance crews. Also, this aspect of CRM has consistently been an issue with flightcrew especially the view that CRM was only a way to keep people happy; a "charm school."

Recommendations: "Leadership/followership," "concern for tasks" and task completion are very relevant to maintenance. However, the building and maintaining of a flightdeck, or "extended" (cabin crew, dispatch, other) flight ops team, and the team approach to tasks and responsibilities, would need to be modified for maintenance ops---at the worker level and above.

At this point, consideration could be given to an MRM training approach that was multi-level, involving middle and upper management. This could be done either in a "diagonal slice" method or separate training for management levels.

What Now?

The Basic Step

The first order of business must be to inspect and evaluate the CRM training model and its components, in order to ascertain what is not a part of CRM and needs to be included in MRM training development. This is best done by:

- (1) a small cadre of CRM experts to provide insight and explanation of the CRM training components
- (2) a small cadre of AMTs
- (3) a small cadre of aircarrier maintenance mid-level and also upper management
- (4) a small cadre of developers and instructors for maintenance training

The Basic Questions:

- (1) Who should develop the training?
- (2) Who should be trained?
- (3) What should be trained?

(4) a. How do you introduce the training?

b. Where should training take place?

c. How much training is required?

(5) What are the (performance) objectives?

We have the [CRM](#) answers for these questions, but we must be aware that over the years, the CRM answers have varied and changed and, in at least 3 major carriers, were significantly changed as late as 1996.

Recommendation and a Start Point

[MRM](#) training developers need to attempt a difficult task: To go back to Square One and, at the same time, quickly go forward. This can be done if there is a realization that what can be gotten from [CRM](#) training is limited. Even more important, realize that neither the expertise within the CRM community nor the "lessons learned" of CRM have been, as yet, effectively used.

The basic philosophy of [CRM](#) and the basic three-phased model of CRM training are good starting points and paradigms. The emphases of CRM on improved performance and safety; on how to identify what the CRM training should contain; on where and how the CRM training should be given to enhance performance; on aiding effective decision-making; on raising safety to new levels. All of these must be made part of [MRM](#).

But, in order to do this, we must go back to Square One. Begin by discarding incorrect assumptions that [MRM](#) can be made in the image and likeness of [CRM](#) and still have MRM be both accepted by [AMT](#)s and effective in enhancing safety. Go back to Square One by not taking the quick and easy pseudo-solutions to the tough issues in developing MRM. And beware the quick "fix." Rather, work with the CRM experts *and* the AMT's to develop effective, quality MRM training.

As the first step past the "new" Square One, start with what it took [CRM](#) long years to do... deal with the "what" and the "how" of identifying the specific performances and behaviors that do make a difference in [AMT](#) performance. Then, develop the particular and specific training elements necessary to achieve improved AMT performance and professionalism. In this effort, CRM and maintenance subject matter experts (SME's) are the key players. Much of the burgeoning MRM training area has neither used CRM experts nor AMT's as the SME cornerstones on which to build. Further, there are powerful and effective tools (knowledge engineering) for using the subject matter experts (SMEs) as the integral part of training development. [9,10,6,12](#)

Step two is to design a Phase I [MRM](#) awareness course that is closely and inextricably linked to the [AMT](#)'s job and function. If not, the AMT's will see MRM as a "touchy-feely" deal which their management seems to want, but has no value to their day-to-day work. In this, as in step one, [SME](#)'s and the knowledge engineering methodologies mentioned above can be used.

The third and most important step is to develop the content of the operational phase (Phase II) so that it is not only maintenance-specific, *but measurably improves performance and reduces error*. This will entail identifying what are the maintenance performance areas (e.g., paperwork errors, reduced air turn-backs) we are looking for improvement in. Then, identify or develop the metrics to be used to verify this improved performance.

What of the AMT?

There is both preventive "maintenance" and proactive "maintenance" to be done. On the proactive side, [AMT](#)'s can be aware and make their company aware that MRM training is being developed and given. Indicating to their company that [MRM](#) benefits both the AMT and the company's bottom line--cost reduction through error reduction is one example. AMT's can keep after their company to either send them to an MRM course, or to develop and give company-specific, in-house, MRM training.

The preventive aspect comes into play thusly: If the company decides to do in-house [MRM](#) training, make sure that you, the [AMT](#), is involved from the beginning in MRM course development. AMT's must be the subject matter experts (SMEs) used to develop MRM training--and to instruct the MRM courses. Perhaps the AMT can be teamed with a trainer in this course delivery effort. Make sure, if the company contracts out for MRM training, that the MRM contractor has personnel qualified in aviation and aviation maintenance. Make sure that the MRM course the contractor proposes to give is developed using AMT's, not simply swiped from an existing [CRM](#) course. And, if the contractor proposes to develop the MRM course specifically for your company, make sure you, or other AMT's are used as SMEs in the course development.

If your company chooses to send you, or you choose to go on your own to an [MRM](#) course, ensure that is being given by an established, reputable training company. Make sure that the training company addresses how the course was developed and who the developers were. When you take the course, not only give feedback to the training company, but to your company and your fellow [AMTs](#). Spread the word.

When you evaluate the [MRM](#) course for feedback, please be aware of that rosy glow that comes from having a paid time off from work for training and for training that is usually given in a nice environment. Please try not to let being treated as "first-class citizens" sway your objective and critical evaluation of the course. The training company wants, and needs, accurate feedback to improve the course. Your company and friends need the feedback so that they can choose future MRM training wisely.

And finally, if the company elects to hire a contractor to come in and deliver the [MRM](#) training in-house, make very, very sure that someone has checked into the aviation and aviation maintenance background, qualifications and experience of the contract personnel. This action cannot be too highly emphasized. And, stay aware as well as making your company aware, that as a colleague of mine says, there are some snake-oil sellers out there, many of whom will vouch for each other. So, try to find an objective source to consult about a contractor.

"What If?"

We must be aware that Flight Ops and flightcrew get the lion's share of "attention"--be that "attention" in the form of visibility, training, money or just recognition from their company. [CRM](#) could afford to make mistakes it did and to take 8-10 years to coalesce because CRM was for the flightcrew. [MRM](#) will not have this extended "grace period." MRM will not have the luxury of feeling its way, of having growing pains, of being allowed years to form up, of making mistakes along the way. MRM training may well have one shot; at most two, before it is asked to prove its value or disappear.

If, and until, the [MRM](#) training now being developed changes direction and goes back to Square One, MRM training may well fail in one or all of three ways.

1. Fail by not being seen as valuable and not accepted by the working [AMT](#).
2. Fail by not making any real difference in AMT performance.
3. Finally, fail to survive long enough to make the changes in the [MRM](#) development process, course content and instructional personnel necessary to make it a success.

If the Aviation Industry does go back to Square One, there are three outcomes. First, [MRM](#) training gets better and better--as the courses being developed get more and more specific to an [AMT](#) and to improving job performance. Secondly, the field of MRM training is put on a solid basis and footing. Finally, aviation safety improves, making all of us proud to be a part of the improvement and a little more relaxed when we ourselves fly.

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CREW PERFORMANCE MARKERS

Revision A (4/18/91)

CATEGORY

MARKER

ASSESSMENT

8: Workload Distribution/ Distractions Avoidance

This is a rating of time and workload management. It reflects how well the crew managed to distribute the tasks and avoid overloading individuals. It also considers the ability of the crew to avoid being distracted from essential activities and how work is prioritized.

1) Workload and time are managed to maximize efficiency.

2) Workload is managed to maximize crew efficiency.

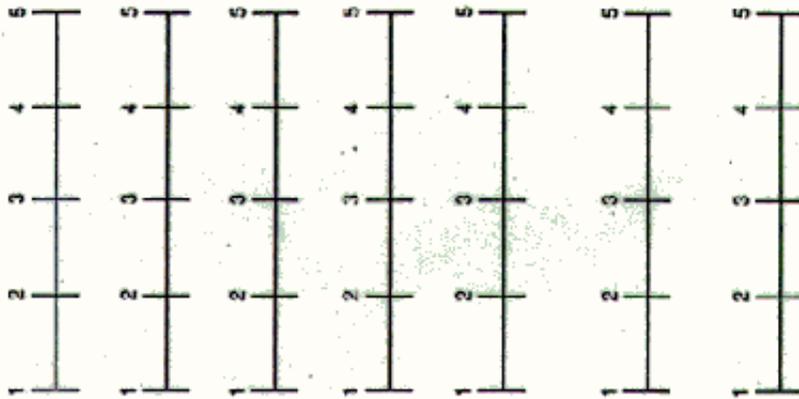
3) Time is managed to optimize crew performance.

4) Workload distribution is clearly communicated and acknowledged to maximize efficiency.

5) Stays "ahead of curve" in preparing for expected or contingency situations (including approaches, weather, etc).

6) Ensures that secondary operational tasks (i.e., dealing with passenger needs, company communications) are prioritized so as to allow sufficient resources for dealing effectively with primary flight duties.

7) Recognizes and reports overloads in self and others.



2
Minimally Acceptable
Performance Improvement
Needed

3
Satisfactory
or Standard
Performance

4
Very Good,
Above Average
Performance

5
Exceptional Performance
Significantly Above
Standard

APPENDIX

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CLUSTER	8: Workload Management and Situational Awareness	This is and we manage reflect crew m describ avoid e individi capacity the cre disacc assessm how wo	I Poor Performance Significantly Below Expectations

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Ronald John Lofaro has been at the [FAA](#)'s Technical Center since 1993, first as program manager in Civil Aviation Security Human Factors and now as the Behavioral Technology lead in the FAA's Airworthiness Assurance [R&D](#) work. Ron transferred to the Technical Center from FAA [HQ](#) in D.C., where, since 1989, he had worked on human factors R&D in flightcrew training, performance and assessment, [CRM](#), [LOFT](#), and [ATCS](#) selection. Prior his FAA HQ stint, he spent 5 years at the [ARI](#) Aviation R&D Unit (US Army Aviation Command) in Alabama. While at the Army Aviation Command, he was a "go-team" member on aviation accident investigations, for one year, with the US Army Safety Center as the human factors investigator.

He has published well over 50 articles and book chapters on Crew Resource Management (CRM); Line Oriented Flight Training (LOFT); Aeronautical Decision Making (ADM); aviator selection and classification; Air Traffic Controller selection; aviation safety; aircrew/pilot training and performance evaluation; aviation security human factors. Ron has been an invited member of the Air Transport Association's (ATA) CRM and Line Oriented Flight Training (LOFT) groups and is now on their Aviation Maintenance Human Factors sub-committee and on The [SAE](#) G-10 Behavioral Engineering Technology Committee. His professional affiliations include membership in the Aerospace Medical Association/Human Factors; The American Psychological Association; The Association of Aviation Psychologists and The Human Factors and Ergonomics Society.

He has three graduate degrees plus post-doctoral work encompassing clinical and counseling psychology, philosophy and education. After completing his doctorate at NYU, Ron spent 12 years as a University professor. Prior to his graduate studies, Ron served as a [USAF](#) flight officer.

As an aviation psychologist, Ron has worked for the past 15 years on human factors [R&D](#) in flightcrew training, performance and assessment; on civil aviation security, and, for the last 18 months, on human factors in aviation maintenance.