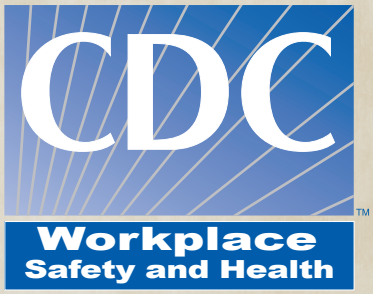

Assessment of Visual and Neurologic Effects Among Video Hub Employees — New York

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Health Hazard Evaluation Report
HETA 2011-0149-3165
September 2012

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention

NIOSH *National Institute for Occupational Safety and Health*

The employer shall post a copy of this report for a period of 30 calendar days at or near the workplace(s) of affected employees. The employer shall take steps to insure that the posted determinations are not altered, defaced, or covered by other material during such period. [37 FR 23640, November 7, 1972, as amended at 45 FR 2653, January 14, 1980].

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Acknowledgments

Abbreviations

1080i	1080 interlaced
3-D	Three-dimensional
HHE	Health hazard evaluation
LCD	Liquid crystal display
LED	Light emitting diode
NAICS	North American Industry Classification System
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PPE	Personal protective equipment
TV	Television
VHO	Video hub office

Highlights of the NIOSH Health Hazard Evaluation

The National Institute for Occupational Safety and Health received a request for a health hazard evaluation at a video hub office in New York. The union submitted the request because of concerns about visual and neurological symptoms among employees who monitored television displays.

What NIOSH Did

- We visited the facility on February 2–3, 2012.
- We evaluated employees' visual and neurologic symptoms and workplace conditions.
- We measured viewing distances from desktop workstations to wall monitors.
- We talked with employees about their work and health concerns.
- We reviewed employee medical records and logs of work-related injuries and illnesses.

What NIOSH Found

- The video hub office was well maintained.
- Most employees reported multiple symptoms when at work. The most commonly reported symptoms were eyestrain, headache, and body aches.
- The distance from the first row of desktop monitor workstations to the wall monitors was approximately 84 inches. The average distance from the user to the desktop monitor was 37 inches. As a result, looking back and forth between nearby and far objects that are different distances may cause eyestrain.
- The desktop monitors varied in brightness and contrast settings. Some monitors were not at the same level or angle.
- The chairs in the video hub were adjustable, but did not have headrests.
- Video hub office technicians worked 10-hour shifts with 4 days on and 3 days off. Every 2 months technicians rotated between 5 different shifts covering 24 hours. Shift work may increase health and safety risks by disturbing sleep and circadian rhythms.
- Most employees thought management did an adequate job of letting them know what was being done to address workplace concerns.

What Managers Can Do

- Provide employees with adjustable ergonomic chairs. These will help increase employee comfort and improve their ability to view multiple monitors.

- Use computer monitors that are height adjustable and have non-glare screens. Regular cleaning should improve visibility and reduce eyestrain.
- Encourage employees to use proper posture when viewing monitors. Also, encourage employees to take breaks to stretch and rest their eyes.
- Encourage employees to report any health concerns that may be related to their work to their health care provider.
- Promptly address any concerns that employees report. The employees should be notified about what is being done to address the concern and what future actions are planned.
- Evaluate work shift scheduling. Keep consecutive night shifts to a minimum, and consider forward rotating shifts.

What Employees Can Do

- Report all health and safety concerns to your manager.
- Seek care from an occupational health physician if you have symptoms or concerns related to your work. If you are having problems with your eyes you should see an optometrist or ophthalmologist.
- Wear the appropriate personal protective equipment. Laser glasses, 3-D glasses, and earmuffs may protect you while at work.

Summary

NIOSH evaluated concerns that excessive visual stimuli in their work environment contributed to employees' visual and neurological symptoms. Most employees reported one or more health symptoms that may have been related to their job duties. NIOSH made ergonomic and procedural recommendations to decrease symptoms and improve employee comfort.

In September 2011, NIOSH received a union request for an HHE concerning visual and neurological symptoms among employees at a VHO in New York. Employees thought their symptoms may have been associated with long-term monitoring of multiple standard and high definition fiber-optic fed TV displays for audio and video imperfections. NIOSH conducted a site visit on February 2–3, 2012.

We interviewed employees in a private setting to discuss their health and workplace concerns and reviewed medical records. The distances between video monitors and employee workstations were measured. During our interviews, 10 of 12 employees reported one or more health symptoms; most reported eyestrain, headache, pain or body aches, and drowsiness. A history of migraine headaches that occur more frequently at work was reported by 3 of 12 employees. We found the distance from the first row of desktop monitor workstations to the wall monitors was approximately 84 inches. The average distance from the user to the desktop monitor was 37 inches. As a result, looking back and forth between nearby and far objects that are different distances may cause eyestrain. We provided recommendations to managers and employees to help lessen eye strain and ergonomic complaints while at work.

Keywords: NAICS 517210 (Wireless Telecommunications Carriers [except Satellite]), neurologic symptoms, television monitors, computer, telecommunication, LED, vision symptoms, video hub office

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In September 2011, NIOSH received a request for an HHE at a telecommunications VHO in New York. The Communication Workers of America local union submitted the request on behalf of VHO employees who were concerned about health effects that included headache, nausea, and visual impairments (blurred vision, double vision, and eyestrain). Some employees felt these symptoms were a result of continuous visual monitoring of multiple standard and high definition fiber-optic fed TV and computer displays, including a 3-D monitor. Prior to the site visit, we requested and received a roster of current employees and OSHA Form 300 Injury and Illness Logs from 2005–2010. Managers also provided pictures of the VHO and a description of video hub technician general duties, qualifications, and training.

During the site visit on February 2–3, 2012, we met with union, management, and employee representatives to discuss the NIOSH HHE Program and the request. We toured the video hub area, telecommunications equipment room, equipment building room, equipment workshop room, antenna room, and generator room. During the tour, we observed work processes, practices, and workplace conditions, and spoke briefly with employees in the video hub area. We also interviewed a sample of employees during the site visit and by phone. Managers, engineers, and video hub technicians from morning, day, and night shifts participated in these voluntary, confidential interviews. We also measured workplace viewing distances to determine if the distances complied with the standards for ergonomic workplace design.

Background

The building that housed the VHO was constructed in 1929; however, the VHO itself was constructed in June 2008 on the building's second floor. The company operated 12 VHOs plus other smaller remote sites nationwide. VHOs take channel signals for their region and prepare them for distribution to customers. Employees include managers, engineers, and VHO technicians; the technicians are represented by the Communication Workers of America.

Process Description

The telecommunication facility was a 24-hour operation where employees monitored displays for signal degradation as well as audio and video imperfections to maintain acceptable picture and

sound quality. Channels were monitored in standard and high definition. Specifically, VHO technicians analyzed and distributed content through a fiber-optic network for three local and national areas. Technicians also monitored the emergency alert system and placed advertisement content locally and nationally. Advertisers sent their commercials to the VHO, and the technician inserted them into programming as required.

Work schedules for VHO technicians included five shifts:

1. 12 p.m. to 10 a.m.
2. 6 a.m. to 4 p.m.
3. 10 a.m. to 8 p.m.
4. 4 p.m. to 2 a.m.
5. 8 p.m. to 6 a.m.

VHO technicians rotated every 2 months with 4 days on and 3 days off for 10-hour shifts. For example, five employees worked for the first half of the week, and another five employees worked the last half of the week. However, some did not rotate because of seniority or medical reasons. Engineers rotated every 3 months between day and night shifts and could take calls from home. Managers worked 5 days a week and were on call 24 hours a day, 7 days a week. Video hub technicians had a mandated 30-minute lunch and two 15-minute breaks per shift. Inside the VHO were a total of 56 fiber-optic fed video monitors and computer desktop flat panel monitors (Figures 1 and 2) as follows:

- Nine workstations, with three rows containing three workstations each. Each workstation had four 20-inch computer desktop flat panel monitors, for a total of 36 monitors.
- A 42-inch 1080i LCD used to monitor an unmanned local VHO for security reasons
- A series of set top cable boxes with three 42-inch LED 1080i monitors used for troubleshooting on both sides of the VHO area desktop environment (six total)
- A 50-inch 3-D monitor that was used for programming on a limited basis
- Six 42-inch (two brands) LCD 1080i monitors with fixed tilt about 30 degrees downward from the wall
- Six Barco branded (highest resolution) displays with "thumbnail widgets" (split screens) parallel to the wall

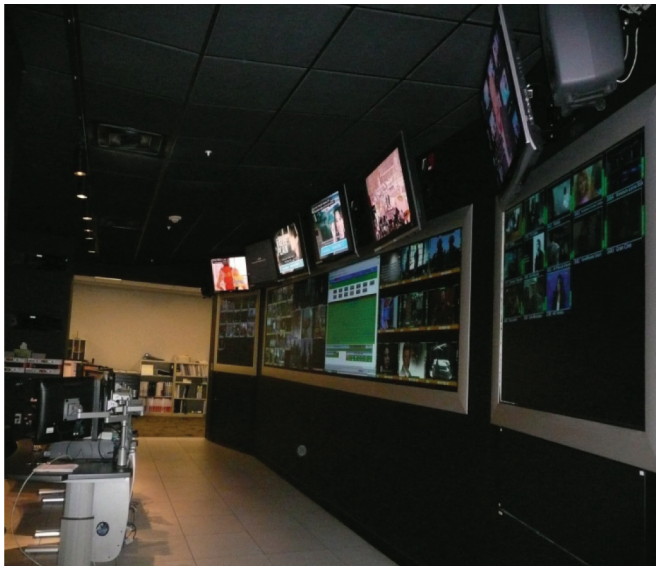

Figure 1. On the wall are fiber-optic fed video monitors in the VHO–Barco branded and 42-inch LCD displays.

Figure 2. Employee surveying the fiber-optic fed video wall monitors (channel scan) and "thumbnail widgets" (split screens) on Barco branded screens in the VHO.

VHO employees typically sat in the first row of workstations closest to the wall monitors in the VHO area. This set-up facilitated access to the set top cable boxes for calibrating the remote control to the display monitor.

VHO employees were responsible for identifying audio and video impairments inside and outside the VHO. They maintained primary and secondary channels, video on demand, national and

local content reception and processing, advertisement inserts, and media guide content inserts. Employees reported that some of their duties included the following:

- Performing routine checks every 3 hours
  - Verifying fiber-optic blackout lists on a website and printing a paper copy
  - Visually scanning standard and high definition channels for approximately 30–45 minutes or up to 1½ hours if only one employee on duty per shift
  - Checking thumbnail widgets on Barco branded screens
  - Checking the power generator in case of a power outage
  - Auditing and scanning parts (occasionally)
  - Checking the emergency alert system and video on demand by purchasing a video and checking the main functions
  - Checking the telecommunications equipment room
- Surveilling video broadcast network and equipment
- Inspecting VHO equipment and maintenance on computer desktops
- Performing fiber-optic wire operations occasionally on night shift during a maintenance window event (12 a.m. to 3 a.m.)
- Continuous monitoring for alarms or failed network paths

The telecommunications equipment room was divided into networks for three locations. Each network included numerous encoders for video multiplex streaming, optical fiber routers, servers for monitoring VHO desktop flat panel computers, wireless routers for remote access, power supplies, service and media guide computers, encryption modulators, satellite receiver services, and emergency alert system computers.

The equipment building room was used by contractors to build equipment that was transferred to the care of the telecommunication network facility for maintenance. The equipment workshop room was used to store spare parts, cables, and tools. The antenna room provided antenna grounding for protection from lightning strikes. The power generator room was downstairs from the VHO floor and had a 750 kilowatt backup generator.

OSHA Form 300 Logs of Work-Related Injuries and Illnesses

The OSHA Logs for years 2005–2010 included four injuries. One of the injuries entailed lower back strain as a result of overexertion in a VHO employee. The remaining injuries were in field technicians and a central office worker.

Employee Interviews

We interviewed in person or by phone 12 of 15 employees who were present on the day of the site visit. Three employees declined interviews. Employees were asked to discuss their work responsibilities and practices, PPE use, and any work-related health concerns.

PPE used in the VHO varied among the employees. A few employees chose to wear earmuffs (provided by the company) in the VHO because of the distraction and noise from multiple audio signals. Most employees reported wearing earmuffs in the telecommunications equipment room only if they anticipated a longer stay when repairing or investigating a problem. A previous OSHA site visit found noise levels in this room were 82–85 decibels and did not exceed the permissible exposure limit. Two employees reported not wearing laser glasses because they never evaluated fiber-optic cables. All employees reported wearing 3-D glasses when they checked 3-D programming. When asked about regular comprehensive eye exams, seven employees reported receiving exams within the last year from their personal optometrist; one of these employees was previously diagnosed with phlebitis and dry eye, and one was diagnosed with vestibular migraines associated with photophobia. Four employees reported receiving eye exams every 2 years; one noted needing a stronger eyeglass prescription. One employee reported his last eye exam was 3 years ago.

Participation and Demographics

The VHO had 15 employees, including 5 managers. Demographics of the 12 interviewees were as follows: 12 (100%) males, average age of 49 (range 31–65). The average length of employment with the company was 10 years (range 2–29 years; median 4 years). For the seven VHO technicians interviewed, the average length of

employment was 3 years (range 2–6 years; median 4 years). Seven VHO employees reported that they had previously worked at another VHO.

Employee Symptoms

Of the 12 employees interviewed, 10 reported having health problems that began and occurred only at work; some also noted progression of symptoms over time. Work-related symptoms are listed in Table 1. Eyestrain was the most common work-related symptom; it was reported by 8 of 12 (67%) employees. When asked what they thought caused their symptoms, employees gave various responses, including inactivity, repetition, history of eye and/or migraine headache symptoms, shift work, constantly slouching, and viewing several broadcasts simultaneously. Specific questions related to neurologic conditions were also asked; results are listed in Table 2.

Table 1. Work-related symptoms reported by employees (N=12)

Symptoms	N
Eyestrain	8
Headache	7
Pain or body aches	7
Drowsiness	6
Tinnitus	4
Eye fatigue	4
Body fatigue	4
Dizziness	3
Unsteadiness	3
Blurred vision	2
Disorientation	2
Nausea	1

Table 2. History of specific neurological conditions reported by employees (N=12)

Health Condition	N
Migraines	3
Motion sickness	2
Nystagmus (involuntary eye movement)	1

Medical Record Review

We reviewed medical records for one VHO employee. This employee underwent several tests conducted by a variety of medical specialists to evaluate their dizziness, migraines, unsteadiness, vertigo, muscle aches, and tinnitus (ear ringing). The employee's medical record indicated that the symptoms may or may not have been related to work, and the cause of vertigo was unknown. A neuro-ophthalmologic consultation failed to determine the precise nature of the visual changes. The employee's physician recommended refraining from watching television in social and occupational settings.

Health and Safety Concerns

A common employee concern was the practice of having one employee on duty at a time, especially during nights and weekends. This required employees to perform routine 3-hour checks consecutively, and the concern was that this schedule contributed to their symptoms. Most interviewed employees believed that the employer appropriately communicated the steps taken to evaluate and resolve potential health hazards and issues in the workplace.

Work Practices

When asked how much time they spend continuously watching the monitors without a break, most employees reported 30 minutes to 1½ hours during a channel scan that was performed daily every 3 hours.

Managers stated that in addition to the scheduled breaks employees were free to move around the facility. VHO technicians reported that when there was only single coverage (usually during nights or weekends) they usually worked together with the VHO engineers to coordinate breaks.

We measured the distance from the first row of desktop monitor workstations (the row most of the VHO employees operate in) to the wall monitors. The approximate distance was 84 inches. The typical distance from the user to the desktop monitor was 37 inches. Managers mentioned that the VHO employees' operation workstation location was mostly based on what the employees felt most comfortable with, which determined the distance.

Discussion

VHO employees were required to constantly view several monitors at the same time. This may lead to occupational asthenopia (eyestrain) and other symptoms that are grouped together under the term computer vision syndrome [Anshel 2007]. Computer vision syndrome is a complex of eye and vision problems related to near-computer use [AOA 2011]. Wall-mounted LCD displays and computer monitors on desktop workstations at the VHO facility provided opportunity to develop eyestrain and other visual symptoms.

The terms eyestrain and eye fatigue are typically used interchangeably and are characterized by internal and external symptoms. Internal symptoms include pain and headache. Eye dryness and irritation are external symptoms and are usually experienced when reading in the presence of glare, flickering light, and small font size [Anshel 2007]. According to Gowrisankaran et al., decreased blink rate (eye dryness) and eyestrain are associated with computer work, cognitive load, and visual stress of a task [Gowirsankaran et al. 2012]. Computer-related dry eye may be caused by decreased blink rate, high gaze angle, or dry office environment [Anshel 2007].

Headaches, blurred vision, and diplopia (double vision) occur when the eyes try to compensate for a deficiency in focusing ability and uncorrected pre-existing vision conditions [AOA 2011]. Visual symptoms result from visual stress on the cross-linkages between the processes of accommodation (focusing) and vergence (fixating on near and far objects that require visual tracking of moving objects) [Barrett 2003]. The resting point of vergence changes with viewing angle. For those who exhibit a change in their resting point of vergence when looking up and down, a downward gaze angle significantly reduces headaches and eyestrain and, to a lesser extent, blur and mental fatigue [Tyrrell and Leibowitz 1990]. Focusing on targets that differ from the eye's resting points requires help from extraocular and intraocular muscles [Sommerich et al. 2001].

Factors contributing to eyestrain include individual vision characteristics, personal work habits, and workplace conditions. Other factors such as improper viewing angle/focal distance, inappropriate lighting/glare, and screen characteristics such as contrast, flicker, and jitter may lead to eyestrain [Clark 1996]. Workers over 40 years of age are predisposed to eyestrain (headache, eye fatigue, and irritation) because they typically require higher illumination levels than younger workers to perform the same job [NIOSH 1998]. The World Health Organization

recommends an eye examination prior to employment and then periodic examinations beyond age 40 years, especially for individuals who report musculoskeletal or eyestrain symptoms [WHO 1990]. The American Optometric Association recommends an eye examination for employees working in occupations that are "highly demanding visually or eye hazardous" every 1 to 2 years for those 18–60 years of age on the basis of an optometrist's professional judgment. Employees age 61 and older should have examinations at least annually or more frequently on the basis of their personal medical history [AOA 2005].

Eyestrain and other related neurologic symptoms such as disorientation, dizziness, unsteadiness, and nausea may be a result of motion sickness or viewing objects moving in a virtual environment setting (including 3-D properties). Visual vertigo is defined as visual environments with large or repetitive moving visual patterns [Bronstein 2004]. The trigger for visual vertigo is visual; however, the symptoms are vestibular in nature. The goal of treatment is to increase tolerance to visual stimuli [Bronstein 2004]. Most employees, however, reported that vision problems experienced while at work ceased once they were at home. Individuals with visual vertigo may experience prolonged vision problems when not at work, and symptoms may worsen if not addressed [AOA 2011].

Eye movement occurs with repetitive and static postures during computer use. Repetitive posture is repeating a movement for an extended period of time, and static posture is maintaining a posture for an extended period of time [Anshel 2007]. Not only do computer use and video monitor displays create awkward eye postures, but they also create awkward musculoskeletal postures. In the study by Grandjean et al. most operators preferred to lean backward in their chairs even if the chairs were not suitable for that posture [Grandjean et al. 1983]. The VHO employees reported a similar preference for leaning back in chairs.

Sommerich et al. concluded that computer monitor viewing angle significantly affected muscle activity, posture, and performance. The approximate distance from the user and the computer monitor at the VHO was 37 inches. Sommerich et al. found an average preferred distance ranging from 29.5 to 32.7 inches and noted that employees did not vary the distance when viewing angles of the monitors changed. Sommerich et al. recommend a practical distance of 18–30 inches to decrease work-related musculoskeletal

Discussion (continued)

symptoms and help maintain an upright posture [Sommerich et al. 2001]. The recommended visual display distance is between 19.6 and 39.4 inches [ANSI/HFES 2007].

Because VHO services were provided 24 hours a day, most employees usually rotated shifts. Shift work, especially working at night, can lead to sleep and circadian rhythm disturbances and decreased work performance. Even employees who consistently work at night never fully adjust [Rosa and Colligan 1997]. Rotating workers forward from evening to night shifts rather than backwards from night to evening shifts makes it easier for circadian rhythms to adjust [Knauth and Hornberger 2003].

Conclusions

The VHO telecommunication work environment, which required extensive visual tracking during 10-hour work periods, may have resulted in employees reporting adverse health effects. The recommendations listed below may improve visual accommodation and spatial orientation over long periods of time and should help prevent the visual and neurologic symptoms the employees at the VHO reported.

Recommendations

On the basis of our findings, we recommend the actions listed below to create a more healthful workplace. We encourage the telecommunication company to use a labor-management health and safety committee or working group to discuss the recommendations in this report and develop an action plan. Those involved in the work can best set priorities and assess the feasibility of our recommendations for the specific situation. In most cases, the preferred approach is to eliminate hazardous materials or processes and install engineering controls to reduce exposure or shield employees. Until such controls are in place, or if they are not effective or feasible, administrative measures and/or personal protective equipment may be needed.

Engineering Controls

Engineering controls reduce exposures to employees by removing the hazard from the process or placing a barrier between the hazard and the employee. Engineering controls are very effective at protecting employees without placing primary responsibility of implementation on the employee.

1. Provide ergonomic chairs with headrests, adjustable height controls, lumbar support, and 360-degree swivel capability so it is easier to view and access multiple monitors without twisting. Padding on the seat, back, and armrests helps minimize pressure points and improves comfort.
2. Provide non-glare screens and height adjustable computer monitors for employees. Adjust the brightness so it is approximately the same as the surroundings; adjust contrast as high as possible to eliminate discomfort. Clean screens regularly to remove dust that may decrease visibility.

Administrative Controls

Administrative controls are management-dictated work practices and policies to reduce or prevent exposures to workplace hazards. The effectiveness of administrative changes in work practices for controlling workplace hazards is dependent on management commitment and employee acceptance. Regular monitoring and reinforcement are necessary to ensure that control policies and procedures are not circumvented in the name of convenience or production.

1. Encourage VHO employees to position their body with correct upright posture when facing a monitor rather than only moving their neck. Adjust the angled monitors so that they are at a level to reduce neck strain.
2. Require employees to receive a comprehensive eye exam prior to starting work and at a frequency recommended by their optometrist or ophthalmologist. They should discuss the nature of their work with their optometrist. Employees who experience eyestrain and associated symptoms (headache; eyestrain; blurry vision; dry eyes; irritated eyes; eye fatigue; neck, back, and shoulder pain; and double vision) should seek medical attention from an appropriate healthcare provider. Employees who wear glasses or contact lenses and experience eyestrain should see an optometrist to ensure they are wearing the correct eye prescription for computer and distant viewing work.
3. Encourage employees to take more breaks to allow for rest and recovery. Taking short breaks for 5 minutes every hour can give the body and eyes a rest. While on these breaks,

standing up and doing stretches or physical movement will reduce discomfort. Encourage employees to consciously think about blinking often.

4. Continue monthly safety and health committee meetings to provide appropriate training and discuss topics specific to hazards in the VHO. A member of the safety management team should communicate directly with employees who report health and safety concerns to ensure the concern is understood and if applicable, explain what steps are being taken to address the issue.
5. Establish a system to report concerns and meet with appropriate personnel (supervisors, managers, healthcare providers, and others).
6. Advise employees that, in general, the recommended viewing distance from the desktop flat panel monitor to the employee is 18–30 inches; however, the exact distance should be a matter of personal preference based on vision requirements.
7. Review the work shift plan. Keep consecutive night shifts to a minimum. Rotate workers forward from day to night shifts.

Personal Protective Equipment

PPE is the least effective means for controlling employee exposures. Proper use of PPE requires a comprehensive program, and calls for a high level of employee involvement and commitment to be effective. The use of PPE requires the choice of the appropriate equipment to reduce the hazard and the development of supporting programs such as training, change-out schedules, and medical assessment if needed. PPE should not be relied upon as the sole method for limiting employee exposures. Rather, PPE should be used until engineering and administrative controls can be demonstrated to be effective in limiting exposures to acceptable levels.

1. Continue providing all appropriate PPE (3D glasses, laser glasses, and ear muffs).

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Acknowledgments and Availability of Report

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