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RESEARCH, INNOVATION, RESULTS



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Articles are published in Uzbek, Russian, and English, ensuring a wide-reaching audience and fostering cross-cultural academic exchange. As a beacon of academic excellence, the "Journal of Transport" continues to serve as a vital conduit for knowledge dissemination, collaboration, and innovation in the transport sector and related fields.

Systematic methods for assessing and managing occupational safety of train drivers

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Abstract:

The article examines the issues of assessing and managing occupational safety at railway transport enterprises, in particular, train drivers performing shunting work. The purpose of the study is to systematically identify dangerous and harmful factors that arise during the work of train drivers, assess occupational risks and justify organizational, technical and ergonomic measures aimed at reducing them. The study analyzed the possibilities of using hazard identification, probability and consequence assessment, risk matrix, mathematical modeling, RULA, REBA and OWAS ergonomic assessment methods. It was found that the work of a train driver is complexly affected by the composition of the moving train, work between cars, boarding and disembarking from cars, switchgear, slipping, electrical hazards, adverse meteorological conditions, noise, vibration, physical and psycho-emotional loads. As a result of the study, a continuous management model was proposed, consisting of hazard identification, risk assessment, information collection, mathematical modeling, selection of protective measures, automated monitoring and reassessment. This approach can serve as a scientific and practical basis for a comprehensive assessment of the working conditions of train drivers and the reduction of occupational risks.

Keywords:

train driver, occupational safety, occupational risk, shunting operations, ergonomic loading, meteorological conditions, risk factor, automated monitoring, Safety-I, Safety-II

Poyezd tuzuvchilarining mehnat xavfsizligini baholash va boshqarishning tizimli usullari

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Annotatsiya:

Maqolada temir yo'l transporti korxonalarida, xususan, manyovr ishlarini bajaruvchi poyezd tuzuvchilarining mehnat xavfsizligini baholash va boshqarish masalalari tadqiq etilgan. Tadqiqotning maqsadi poyezd tuzuvchilarining mehnat faoliyati davomida yuzaga keladigan xavfli va zararli omillarni tizimli ravishda aniqlash, kasbiy risklarni baholash hamda ularni kamaytirishga qaratilgan tashkiliy, texnik va ergonomik choralarini asoslashdan iborat. Tadqiqotda xavflarni identifikatsiyalash, ehtimollik va oqibat og'irligini baholash, risk matritsasi, matematik modellash, RULA, REBA va OWAS ergonomik baholash usullaridan foydalanish imkoniyatlari tahlil qilindi. Poyezd tuzuvchisining ish faoliyatiga harakatdagi tarkib, vagonlar orasida ishlash, vagonlarga chiqish-tushish, strelkali o'tkazgichlar, sirpanish, elektr xavfi, noqulay meteorologik sharoitlar, shovqin, vibratsiya, jismoniy va psixologik yuklamalar kompleks ta'sir ko'rsatishi aniqlandi. Tadqiqot natijasida xavflarni aniqlash, riskni baholash, axborotni yig'ish, matematik modellash, himoya choralarini tanlash, avtomatlashtirilgan monitoring va qayta baholashdan iborat uzluksiz boshqaruv modeli taklif etildi. Mazkur yondashuv poyezd tuzuvchilarining mehnat sharoitlarini kompleks baholash va kasbiy risklarni kamaytirish uchun ilmiy-amaliy asos bo'lib xizmat qilishi mumkin.

Kalit so'zlar:

poyezd tuzuvchisi, mehnat xavfsizligi, kasbiy risk, manyovr operatsiyalari, ergonomik yuklama, meteorologik sharoit, xavf omili, avtomatlashtirilgan monitoring, Safety-I, Safety-II.

1. Kirish

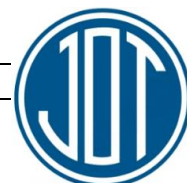
Temir yo'l transporti tizimining barqaror va xavfsiz faoliyat yuritishi ko'p jihatdan saralash stansiyalarida poyezdlarni shakllantirish va tarqatish ishlarining sifatiga bog'liq. Ushbu texnologik jarayonlarni amalga oshiruvchi

poyezd tuzuvchi (poyezd tuzuvchi yordamchisi) kasbi temir yo'l sohasi bo'yicha eng yuqori jarohatlanish xavfiga ega mutaxassisliklardan biri hisoblanadi [1].

Poyezd tuzuvchisining mehnat faoliyati harakatlanayotgan manevr tarkiblari, og'ir texnik uskunalar, ochiq havodagi o'zgaruvchan meteorologik sharoitlar

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hamda sutkaning turli vaqtlaridagi (shu jumladan, tungi) yuqori ruhiy va jismoniy yuklamalar ostida kechadi. Amaldagi mehnat muhofazasi tizimlari asosan sodir bo'lgan hodisalarni qayd etish va reaktiv reagirlashga (Safety-I) asoslangan bo'lib, ular xavflarni oldindan prognoz qilish hamda proaktiv profilaktika qilish (Safety-II) imkoniyatini to'liq qamrab olmaydi [2].

Ushbu tadqiqotning maqsadi poyezd tuzuvchilarining mehnat faoliyatidagi xavf va zararli omillarni kompleks tahlil qilish, kasbiy risklarni miqdoriy va sifat jihatidan baholash usullarini takomillashtirish hamda mehnat xavfsizligini oshirish bo'yicha tizimli tavsiyalarni ishlab chiqishdan iborat.

Adabiyotlar tahlili

Temir yo'l transportida mehnat xavfsizligi va kasbiy risklarni boshqarish masalalari bo'yicha mahalliy va xorijiy olimlar tomonidan bir qator ilmiy-tadqiqot ishlari olib borilgan [3-11].

Sanoat xavfsizligi va transportda risklarni boshqarish sohasidagi tadqiqotlarda kasbiy xavflarni ehtimollik va oqibatlar og'irligi ko'paytmasi sifatida baholash konsepsiyasi keng yoritilgan. Xususan, temir yo'l hodisalarini tahlil qilishda inson omili (human factor) va uning mehnat sharoitlariga bog'liqligi yetakchi sabablardan biri sifatida ko'rsatiladi [4].

Ergonomik xavflarni baholash sohasida McAtamney va Corlett (RULA) [5], Hignett va McAtamney (REBA) [6], hamda Karhu va boshqalar (OWAS) [7] tomonidan ishlab chiqilgan metodologiyalar ishchilarning statik va dinamik yuklamlarini, noqulay ish holatlarini (non-neutral postures) hamda mushak-skelet tizimi kasalliklari yuzaga kelish xavfini miqdoriy baholashda yuqori samaradorlikni ko'rsatgan.

Biroq, mavjud ilmiy manbalarda poyezd tuzuvchilarining faoliyatiga ta'sir etuvchi texnik, meteorologik, ergonomik va psixofiziologik omillarni yagona integral ko'rsatkich orqali kompleks baholash hamda ularni avtomatlashtirilgan monitoring tizimlariga integratsiya qilish masalalari yetarlicha yoritilmagan.

2. Tadqiqot metodologiyasi

Poyezd tuzuvchisining mehnat xavfsizligini boshqarish tizimining asosiy maqsadi manyovr ishlarini bajarish jarayonida xodim hayoti va sog'lig'iga xavf tug'diruvchi omillarni oldindan aniqlash, ularning ta'sirini kamaytirish va xavfsiz mehnat sharoitlarini yaratishdan iborat.

ISO 45001 xalqaro standarti mehnatni muhofaza qilish va xavfsizlikni boshqarishda xavflarni aniqlash, risklarni baholash, boshqaruv choralarini amalga oshirish va tizimni doimiy takomillashtirish tamoyillariga asoslanadi [4].

Xalqaro mehnat tashkilotining ILO-OSH 2001 yo'riqnomasida ham mehnat xavfsizligini boshqarish tizimini korxonaning umumiy boshqaruv tizimi bilan integratsiyalash zarurligi ko'rsatilgan [8].

Boshqaruv tizimining maqsadini asoslash uchun poyezd tuzuvchisining mehnat faoliyatini tavsiflovchi asosiy ko'rsatkichlar aniqlanishi lozim. Bu ko'rsatkichlarga quyidagilar kiradi:

- xavfli operatsiyalar soni;
- harakatdagi tarkibga yaqinlashish chastotasi;
- vagonlarga chiqish-tushish soni;
- ish davomiyligi;
- yurish masofasi;

- jismoniy yuklama;
- ergonomik yuklama;
- meteorologik sharoit;
- yoritish darajasi;
- xodimning psixofiziologik holati;
- xavfsizlik qoidalariga rioya qilish darajasi.

Ushbu ko'rsatkichlarni yagona tizimga birlashtirish orqali poyezd tuzuvchisining mehnat xavfsizligi holatini kompleks baholash mumkin.

Poyezd tuzuvchisining mehnat xavfsizligini matematik modellashtrish. Poyezd tuzuvchisining mehnat xavfsizligini boshqarishda tizimlar nazariyasi matematik modellashtrish usullaridan foydalanish xavfsizlik holatini miqdoriy baholash imkonini beradi.

Mehnat xavfsizligining integral ko'rsatkichini quyidagi ko'rinishda ifodalash mumkin:

$$K_{mx} = \Sigma \cdot W_i \cdot X_i$$

bunda:

K_{mx} – poyezd tuzuvchisining mehnat xavfsizligi integral ko'rsatkichi;

W_i – xavf omilining vazn koeffitsiyenti;

X_i – tegishli xavf omilining baholangan qiymati.

Tizimli yondashuv xavfsizlikni bir-biridan ajralgan hodisalar yig'indisi sifatida emas, balki o'zaro bog'liq elementlardan tashkil topgan tizim sifatida baholash imkonini beradi [3, 4].

Masalan, poyezd tuzuvchisi uchun harakatdagi tarkib bilan bog'liq xavf eng yuqori ustuvorlikka ega bo'lishi mumkin. Keyingi o'rinlarda vagonlarga chiqish-tushish, meteorologik sharoit, ergonomik yuklama, elektr xavfi va psixofiziologik omillar baholanadi.

Mazkur matematik model yordamida xavfsizlik darajasini vaqt bo'yicha kuzatish va xavfsizlik holatining o'zgarishini prognozlash imkoniyati yaratiladi.

Poyezd tuzuvchisining kasbiy riskini baholash

Kasbiy riskni baholash poyezd tuzuvchisining mehnat xavfsizligini boshqarishning asosiy elementlaridan biridir. Xalqaro xavfsizlik boshqaruvi amaliyotida xavfni aniqlash va uning ehtimoliy oqibatlarini baholash xavfsizlikni boshqarishning muhim bosqichi sifatida qaraladi [8, 9]. Kasbiy riskni baholash poyezd tuzuvchisining mehnat xavfsizligini boshqarishning asosiy elementlaridan biridir.

Riskni soddalashtirilgan holda quyidagicha ifodalash mumkin:

$$R = P * S$$

bunda:

R – kasbiy risk;

P – xavf yuzaga kelish ehtimoli;

S – xavf oqibatining og'irligi.

Poyezd tuzuvchisining ish joyida risklarni baholash quyidagi ketma-ketlikda amalga oshirilishi mumkin 1-rasm.

Risk darajasiga qarab xavflarni past, o'rta, yuqori va juda yuqori guruhlariga ajratish mumkin.

Poyezd tuzuvchisining mehnat xavfsizligini axborot bilan ta'minlash

Poyezd tuzuvchisining mehnat xavfsizligini boshqarishda axborotning o'z vaqtida va to'liq shakllantirilishi muhim ahamiyatga ega.

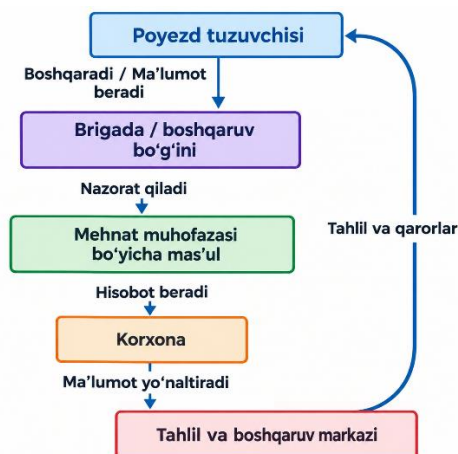




1-rasm. Poyezd tuzuvchisining ish joyida risklarni baholash ketma-ketligi

“O‘zbekiston temir yo‘llari” AJ tizimida poyezd tuzuvchilarining mehnat xavfsizligi holatini baholash uchun zarur axborotlarni yig‘ish, hisobga olish va tahlil qilishning yagona tuzilmasini shakllantirish maqsadga muvofiq.

Axborotlar quyidagi yo‘nalishlarda shakllantiriladi 2-rasm.



2-rasm. Poyezd tuzuvchisining mehnat xavfsizligini oshirishda axborot bilan ta'minlash ketma-ketligi

Poyezd tuzuvchisining mehnat xavfsizligiga ob-havo sharoitlarining ta'siri:

Poyezd tuzuvchisi o‘z mehnat faoliyatini asosan ochiq havoda amalga oshirgani sababli meteorologik sharoitlar uning xavfsizligiga bevosita ta'sir ko'rsatadi. Ularga quyidagilar kiradi: kuchli sovuq, yuqori harorat, yomg'ir, qor, tuman, kuchli shamol, muzlama va yuqori namlik darajasi. Yuqorida sanab o'tilgan poyezd tuzuvchilarning mehnat faoliyatini olib borishda, ayniqsa manyovr ishlarini bajarish jarayonlarini murakkablashtiradi.

Masalan, yomg'ir yoki qor yog'ishi natijasida vagon pog'onalari va ballast yuzasi sirpanchiq bo'lib qolishi mumkin. Bu esa poyezd tuzuvchisining vagonlarga chiqish-tushish jarayonida yiqilish xavfini oshiradi. Tuman yoki kuchli qor paytida ko'rish masofasining kamayishi esa poyezd tuzuvchisi va harakatdagi tarkib o'rtasidagi xavfsiz masofani nazorat qilishni qiyinlashtiradi.

Shu sababli ob-havo sharoitlarini poyezd tuzuvchisining mehnat xavfsizligini baholash modeliga mustaqil parametr sifatida kiritish maqsadga muvofiq.

Poyezd tuzuvchisining mehnat faoliyatini ergonomik baholash

Poyezd tuzuvchisining mehnat faoliyatida ergonomik omillar ham muhim ahamiyatga ega. Xodimning ish jarayonida doimiy yurishi, egilishi, burilishi, vagonlarga chiqishi va tushishi hamda qo'l bilan turli harakatlarni bajarishi jismoniy yuklamani oshiradi.

Ergonomik baholashda quyidagi ko'rsatkichlarni aniqlash mumkin:

- tana egilish burchagi;
- bo'yin holati;
- yelka va tirsak burchaklari;
- bilak holati;
- oyoq va tizza holati;
- statik yuklama davomiyligi;
- takroriy harakatlar soni;
- yurish masofasi;
- vagonlarga chiqish-tushish chastotasi.

Poyezd tuzuvchisining ish holatini baholashda RULA, REBA va OWAS usullaridan foydalanish mumkin. Ushbu metodlar yordamida poyezd tuzuvchisining qaysi ish operatsiyalarida ergonomik xavf yuqori ekanligini aniqlash va ularni kamaytirish bo'yicha texnik hamda tashkiliy choralarni ishlab chiqish mumkin.

RULA metodi ishchining yuqori qo'l qismlari, bo'yin va tana holatini baholash uchun ishlab chiqilgan [8]. REBA esa butun tana holatini baholashga mo'ljallangan bo'lib, turli ish operatsiyalaridagi ergonomik xavfni aniqlash imkonini beradi [5]. OWAS metodi esa ishlab chiqarishdagi ish holatlarini tizimli ravishda baholash uchun qo'llaniladi [6].

Poyezd tuzuvchisining mehnat faoliyatini ergonomik baholashda quyidagi ko'rsatkichlarni aniqlash maqsadga muvofiq:

- tana egilish burchagi;
- bo'yin holati;
- yelka va tirsak burchaklari;
- bilak holati;
- oyoq va tizza holati;
- statik yuklama davomiyligi;
- takroriy harakatlar soni;
- yurish masofasi;
- vagonlarga chiqish-tushish chastotasi.

Ergonomik baholash natijasida poyezd tuzuvchisi uchun eng xavfli ish operatsiyalari aniqlanib, ularni kamaytirish bo'yicha texnik va tashkiliy choralar ishlab chiqilishi mumkin.

3. Natija va muhokamalar

Poyezd tuzuvchisining mehnat xavfsizligini ta'minlash usullari

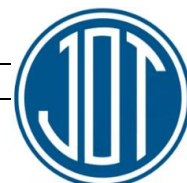
Poyezd tuzuvchisining mehnat xavfsizligini ta'minlash usullarini beshta asosiy guruhga ajratish mumkin.

1. Tashkiliy usullar:

— ish boshlashdan oldin xavfsizlik yo'riqnomasini o'tkazish;

- xodimlarning bilimini muntazam tekshirish;
- manyovr ishlarini xavfsiz tashkil etish;
- ish va dam olish vaqtlarini to'g'ri belgilash;
- xavfli vaziyatlarni qayd etish va tahlil qilish.

2. Texnik usullar:



- signalizatsiya tizimlarini takomillashtirish;
- aloqa vositalaridan foydalanish;
- vagon pog'onalari va tutqichlarini ergonomiklashtirish;

- sirpanishga qarshi yuzalarni qo'llash;
- ish joylarini yetarli yoritish;
- xavfsizlik belgilarini o'rnatish.

3. Ergonomik usullar:

- ish holatini optimallashtirish;
- ortiqcha egilish va burilishlarni kamaytirish;
- vagonlarga chiqish-tushishni xavfsizlashtirish;
- jismoniy yuklamani me'yorlashtirish;
- ish joyini poyezd tuzuvchisining antropometrik xususiyatlariga moslashtirish.

4. Shaxsiy himoya vositalari:

Poyezd tuzuvchisini:

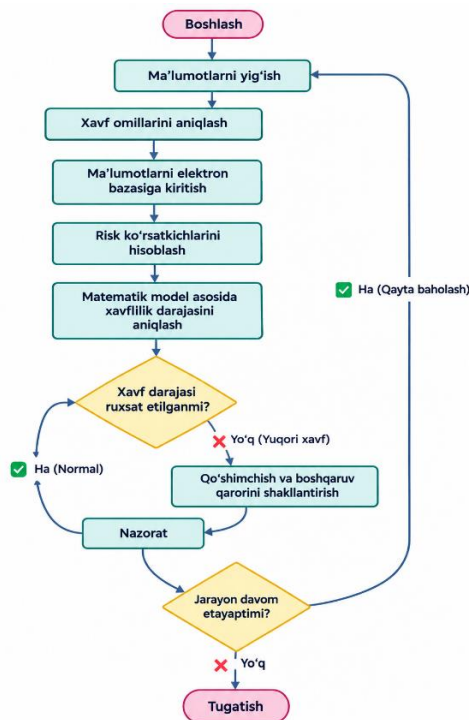
- himoya kaskasi;
- signal beruvchi maxsus kiyim;
- sirpanishga qarshi maxsus poyabzal;
- himoya qo'lqoplari;
- mavsumiy maxsus kiyim bilan ta'minlash zarur.

5. Axborot-tahliliy usullar:

- xavfsizlik ko'rsatkichlarini elektron qayd etish;
- xavfli vaziyatlarni ma'lumotlar bazasida saqlash;
- risklarni avtomatik hisoblash;
- xavfsizlik darajasini monitoring qilish;
- xavf oshgan holatlarda ogohlantirish tizimini joriy etish.

Mehnat xavfsizligini baholashni avtomatlashtirish

Poyezd tuzuvchisining mehnat xavfsizligini boshqarishda axborot texnologiyalaridan foydalanish xavflarni tezkor aniqlash imkonini beradi 3-rasm.



3-rasm. Poyezd tuzuvchisining mehnat xavfsizligini boshqarish algoritmi

Bunday tizim poyezd tuzuvchisining mehnat sharoitidagi o'zgarishlarni muntazam kuzatish va xavf darajasi oshgan hollarda profilaktik choralarni o'z vaqtida belgilash imkonini beradi. Bu yondashuv Safety-I va Safety-II konsepsiyalarida ko'rsatilgan xavfsizlikni tizimli va proaktiv boshqarish tamoyillariga mos keladi [3].

Poyezd tuzuvchilarining mehnat xavfsizligini oshirish bo'yicha tavsiyalar

Poyezd tuzuvchilarining mehnat xavfsizligini oshirish uchun quyidagi tavsiyalarni amalga oshirish maqsadga muvofiq:

1. Poyezd tuzuvchisining ish jarayonidagi xavf omillarining yagona tasnifini ishlab chiqish.

2. Kasbiy risklarni miqdoriy baholash metodikasini takomillashtirish.

3. Ergonomik xavflarni RULA, REBA va OWAS usullari asosida baholash.

4. Meteorologik sharoitlarni xavfsizlik darajasini baholash modeliga kiritish.

5. Mehnat xavfsizligi bo'yicha ma'lumotlarni elektron shaklda yig'ish va saqlash.

6. Xavfsizlikning integral ko'rsatkichini aniqlash uchun matematik model ishlab chiqish.

7. Xavf darajasini avtomatik aniqlash va ogohlantirish tizimini joriy etish.

8. Vagon pog'onalari va tutqichlarini ergonomik jihatdan takomillashtirish.

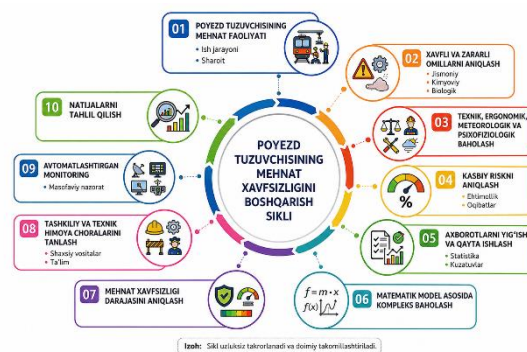
9. Poyezd tuzuvchilarining mavsumiy mehnat sharoitlariga mos maxsus kiyimlarini takomillashtirish.

10. Mehnat xavfsizligi bo'yicha davlat va tarqoq me'yoriy talablaridagi o'zgarishlarni korxona standartlariga muntazam kiritib borish.

Mazkur tavsiyalar mehnat xavfsizligini boshqarishning doimiy takomillashtirish tamoyiliga asoslanadi [8].

Poyezd tuzuvchisining mehnat xavfsizligini boshqarishning taklif etilayotgan modeli.

Tadqiqot natijalaridan kelib chiqib, poyezd tuzuvchisining mehnat xavfsizligini boshqarishning quyidagi modeli taklif etiladi 4-rasm.



4-rasm. Poyezd tuzuvchisining mehnat xavfsizligini boshqarish sikli

Mazkur model mehnat xavfsizligini uzluksiz boshqarish sikli sifatida qarash imkonini beradi. Ushbu yondashuv xavfsizlikni oldindan boshqarish, xavflarni nazorat qilish va tizimni doimiy takomillashtirish tamoyillariga asoslanadi [3-7].

4. Xulosa

Poyezd tuzuvchisining mehnat faoliyati temir yo'l transportidagi yuqori xavfli mehnat jarayonlaridan biri bo'lib, uning xavfsizligi ko'plab texnik, tashkiliy, ergonomik, meteorologik va psixofiziologik omillarga bog'liq.

Tadqiqot natijasida poyezd tuzuvchisining mehnat xavfsizligini ta'minlashni beshta asosiy yo'nalish - **tashkiliy, texnik, ergonomik, individual himoya va axborot-tahliliy usullar** asosida tashkil etish maqsadga muvofiqligi aniqlandi.

Poyezd tuzuvchisining mehnat xavfsizligini boshqarish maqsadini asoslashda matematik modellashdan foydalanish xavfsizlikka ta'sir qiluvchi omillarni miqdoriy baholash va ularning ustuvorligini aniqlash imkonini beradi [3, 10]. Shu bilan birga, mehnat xavfsizligi to'g'risidagi axborotlarni yig'ish, hisobga olish va tahlil qilishni avtomatlashtirish xavfli vaziyatlarni tezkor aniqlash va boshqaruv qarorlarini o'z vaqtida qabul qilish imkonini beradi.

Poyezd tuzuvchisining mehnat faoliyati ochiq havoda amalga oshirilishi sababli meteorologik omillarni alohida baholash zarur. Havo harorati, yog'ingarchilik, tuman, shamol, muzlama va ko'rish masofasi kabi omillarni xavfsizlik modeliga kiritish real mehnat sharoitini yanada aniqroq ifodalash imkonini beradi.

Bundan tashqari, poyezd tuzuvchisining ish holatlarini RULA, REBA va OWAS metodlari yordamida ergonomik baholash orqali mushak-skelet tizimiga tushadigan yuklamani aniqlash va xavfli ish operatsiyalarini kamaytirish mumkin [4–11].

Umuman olganda, **“xavfni aniqlash – riskni baholash – axborotni yig'ish – matematik modellash – xavfsizlik darajasini aniqlash – himoya choralarini tanlash – avtomatlashtirilgan monitoring – qayta baholash”** tamoyiliga asoslangan boshqaruv tizimi poyezd tuzuvchilarining mehnat xavfsizligini oshirishning ilmiy-amaliy asosi bo'lib xizmat qilishi mumkin.

Ushbu yondashuv “O'zbekiston temir yo'llari” AJ tarkibidagi stansiyalarda poyezd tuzuvchilarining mehnat sharoitlarini kompleks baholash, kasbiy risklarni kamaytirish va mehnat xavfsizligini boshqarish samaradorligini oshirishga imkon beradi.

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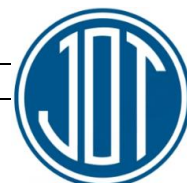
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