

**TABLE 5
SUMMARY OF OIL AND GAS SUB-SECTOR RECOMMENDATIONS**

Key Issues	Recommendations
Small pool of experienced talent in the sector	<ul style="list-style-type: none"> • Promote midstream O&G career opportunities and career path to build industry awareness among secondary school students and college students before they choose which field of study to enter (include student testimonies) • Identify remuneration factors that are key to retain talent and promote these to relevant local and expatriate talent (E.g. individual tax incentive for relocation, family medical benefits, housing accommodation and food subsidies) • Encourage O&G players and IHLs to regularly discuss matters in regard to students' competencies and headcount needs and work together to provide industry-led modules. Consider providing incentives to latent talent (e.g. retirees) to provide training • Develop more women-targeted flexible work arrangements and build awareness of them through campaigns and online platforms (e.g. www.flexiworklife.my) • Work together with relevant bodies to drive recruitment for required foreign talent (especially skilled and semi-skilled talent) with experience in the mid-stream industry.
Difficulty in attracting talent into storage tanks and refineries	<ul style="list-style-type: none"> • Improve and enhance the infrastructure, eateries and recreation centres to attract talent to the targeted storage and refinery locations expecting growth
Fresh graduates lack industry-ready skills for oil and gas	<ul style="list-style-type: none"> • Work with Talent Corp to engage with O&G midstream industry players in IM and share with them the current incentives available for organisations with a structured internship programme • EAC to revise the credit hours criteria to allow IHLs a flexibility of choosing six months of training duration • Ministry of Human Resources can link industry players with training centres (e.g. ILP Mersing, SIRIM) to come up with bridging courses. • Leverage on ILP Mersing's experience in the O&G sector e.g. Petronas and ILP Mersing for O&G welders • Develop an industry-led Centre of Excellence (COE) via collaboration among industry players to provide the facilities required to train the upcoming talent.

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THE PROBLEMS OF VISION ZERO IN WORK SAFETY

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ABSTRACT

During the twentieth century, a remarkable transition occurred in how we look at the relationship between safety and the human factor. In the first half of the twentieth century, the human factor was mostly seen as the cause of safety problems. After that, the human was seen more as the recipient of safety problems. Safety interventions targeted the system. Safety problems were addressed by controlling the technology, the context surrounding workers. Many organizations today rely on safety management systems, loss prevention systems or similar bureaucratic machineries to count and tabulate negative events. A pursuit of zero (free from incidents and injuries) is part of many organizations' stated goals. This, however, has some negative effects as well, including a stigmatization of workers involved in incidents, the manipulation of dependent variables, and gaming of numbers. Moving beyond zero will involve seeing people not as a problem to control, but as a solution to harness. It will require seeing safety as a presence of capabilities to make things go right, rather than the absence of negatives. And it means we recommit to safety as a responsibility for people who do our safety-critical work, rather than as a bureaucratic accountability to people above us.

Keywords: Work safety; zero vision; human error; incidents; accidents; human factors

1. THE EMERGENCE OF SYSTEMS THINKING IN WORK SAFETY

1.1. A transition halfway the twentieth century

Our thinking about safety in the workplace has emerged from a substantial shift around the middle of the twentieth century—a shift that was enabled not only by better engineering, but by ideas from psychology, high modernism, and social strategies for risk control. In essence, this shift flipped the assumed respective contributions of

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human and system in the creation and erosion of work safety, and had significant implications for the targets of control and safety improvement (Burnham, 2009; Dekker, 2005):

- In the first half of the twentieth century, the human factor was seen as the major cause of workplace safety trouble. Safety interventions targeted the individual worker—through aptitude testing, selection, training, reminders, sanctions and incentives. Technologies and tasks were seen as fixed: the human had to be picked for, and moulded to them. Individual differences between people were to be exploited to fit the human to the system. Safety problems were addressed by controlling the human. As a typical example of that age: Pure accidents, said safety expert H. B. Rockwell in 1905, don't happen. Rather, "someone has blundered; someone has disobeyed an order or undertaken to reverse a law of nature" (Burnham, 2009, p. 17).
- In the second half of the twentieth century, the human was seen more as the recipient (rather than instigator) of safety trouble—trouble that was created upstream and then handed down by imperfect tools, technologies, or tasks. Safety interventions targeted the system—with better design, better organization. Technology was not taken as fixed but as malleable, to be adapted to human strengths and limitations. Individual differences were much less important than devising technologies and systems that would resist or tolerate the actions of individual workers, independent of their differences. Safety problems were addressed by controlling the technology.

Even though history does not split into two as neatly as this, our thinking about work safety shows a remarkable transition in the targets and strategies of safety improvements, with humans generally seen as both the cause and the target during the first half of the twentieth century, and more as the recipient in the second half. In this paper, I will first briefly lay out this history, and then turn to our current views on work safety. These, as the paper will show, derive as much from the first as from the second half of the twentieth century. Human workers are again often seen as a problem to control; and safety is seen as an absence of negatives, an absence of human deficit. Today, work safety is largely a bureaucratic accountability—to be managed through process, protocol, surveillance, measuring, counting and tabulating (of often irrelevant data). The idea of a zero vision (injury and incident free) is the most obvious instantiation of such high modern thinking about work safety. The article will conclude with an overview of the possibly negative implications of adopting a zero vision.

1.2. Accident-prone workers

Around 1925, independently from each other, British and German psychologists suggested that there were particularly "accident-prone" workers. The inclination to

"accident" (used as a verb back then) was seen as proportional to the number of accidents previously suffered. In England, Eric Farmer, industrial psychologist at Cambridge, began devising tests to identify people who were likely to have accidents, realizing that personal, individual factors contributed to accidents. "The human factor" at the time was thought of not in terms of generalizable psychological or environmental conditions (like fatigue or error traps in equipment design), but characteristics specific to the individual, or, in the vocabulary of deficit of the time, "physical, mental, or moral defects." (Burnham, 2009, p. 61). These negative characteristics could be identified by carefully testing and screening workers—something for which psychological institutes were developing ever cleverer simulations and contraptions. Psychologically testing new employees and eliminating those who tested badly on efficiency, putatively helped reduce the overall accident rate—something that caught the attention of industries and insurance companies around the world. Accident proneness had become firmly established as an individual and undesirable psychological trait. It kept a growing machinery of *psychotechnik*, of testing and selection, busy well into the Second World War. The tone of the psychologists behind the idea had become bullish, claiming that:

Accident proneness is no longer a theory but an established fact, and must be recognized as an important element in determining accident incidence. This does not mean that knowledge of the subject is complete, or that the liability of any particular individual to accident can with certainty be predicted. What has been shown, so far, is that it is to some extent possible to detect those most liable to sustain accidents. (Farmer, 1945, p. 224)

1.3. Technology, not humans, as the target

Toward the middle of the twentieth century, a remarkable transition occurred, spurred in part by the rapidity and complexity of technological developments during WWII. Behavioural or screening interventions no longer yielded the desired results on accident risk reduction. Instead of trying to change the human so that accidents became less likely, safety thinkers realized that they could, and should, change the technologies and tasks so as to make error and accident less likely. The statistics and research base underneath accident prone people were increasingly seen as suspect too, and such proneness was no longer accepted as a lasting trait. At the same time, the growth of epidemiology gave more credence to the idea of risk groups rather than personality traits and individuals. Risk groups (e.g. young workers, older workers, foreign workers) could be identified with more statistical certainty, and interventions could be targeted at them. In general, the second half of the twentieth century saw humans no longer as just the cause of safety problems—they were the recipients of safety problems: trouble that could be engineered, organized or campaigned away (Dekker, 2005).

TABLE 1
HOW OUR UNDERSTANDING OF THE RELATIONSHIP BETWEEN
SAFETY AND THE HUMAN FACTOR HAS UNDERGONE A REMARKABLE
TRANSFORMATION DURING THE TWENTIETH CENTURY

First half of twentieth century	Second half of twentieth century
Human is cause of trouble	Human is recipient of trouble
Safety interventions target the human through selection, training, sanctions and rewards	Safety interventions target the organizational and technological environment
Technology and tasks are fixed, the human has to be picked for them and adapted to them	Technology and tasks are malleable, and should be adapted to human strengths and limitations
Individual differences are key to fitting the right human to the task	Technologies and tasks should be devised to be error-resistant and error-tolerant, independent of individual differences
Safety problems addressed by controlling the human	Safety problems addressed by controlling the technology
Psychology is useful for influencing people's behaviour, it allows us to engineer people to fit our systems	Psychology is useful for understanding perception, attention, memory and decision making, so that we can engineer systems fit for people

This shift was accompanied by a change in psychological theorizing as well. The first half of the twentieth century was largely animated by behaviourism. This was a psychology that was not interested in mental phenomena, but in moulding and shaping worker behaviour to existing environments. This can be done by using clever systems of selection, rewards and sanctions. Investigating the mind to understand why workers did what they did was not as important as working with their behaviour to get them to do the right thing. The second half of the twentieth century, in contrast, has seen the growth of engineering psychology and cognitive psychology. Mental phenomena once again became important for understanding how best to design and engineer technologies that fit the strengths and limitations of human perception, memory, attention and decision making, whether in general or specific to certain risk groups.

2. HIGH MODERNISM IN WORK SAFETY: SYSTEMS THINKING TO THE MAXIMUM

The shift from humans as the target of safety interventions to technologies and systems was enabled by a number of important developments. The first was obviously the growth of wealth following WWII, which allowed system-level interventions in the

first place (Bernstein, 1996). The post-war period also saw the dominance of high modernism, a mode of Western thinking inspired by the capitalist, governmental and industrial successes of the scientific revolution and Enlightenment. High modernism was characterized foremost by an unflinching faith in the rationality of science and technology. Its grand schemes (e.g. public housing as well as infrastructure road design) were imposed on societies from the top-down to make the world a more linear, controllable, reliable, predictable, standardized and organized place. It was literally "systems thinking" because safety interventions were aimed at the level of systems, not at the individual human participants in them. It made a number of assumptions about the location and nature of expertise for accident prevention and work safety:

- Authority is vested in those who plan, design, manage and engineer, rather than in those who execute. To increase safety, control needs to be taken away from those who execute (e.g. determining speed limits or where to drive on a road surface) (Scott, 1998).
- Users are essentially unable to resist the imposition of high modernism on the execution of their tasks. Deviance is seen as a "violation" and is criminalized.
- The administrative ordering of nature and society, hierarchically imposed from above (expressed in worker training, licensing, workplace design and more).
- Craftsmanship, local expertise, improvisation, and other expressions of diversity are officially frowned upon.

The belief that safety is generated chiefly through planning, process, paperwork, audit trails and administrative work—all at an increasing distance from the operation—has become entrenched in many industries. Originally, the ideas that gave rise to this were empowering and emancipatory, just like human factors intended. Safety was not seen as a problem of only the sharp or operational end of practice. Rather, it had everything to do with how work was organized, resourced, supervised, planned, designed and managed. Increasingly, however, this might become constraining. A focus on safety systems and procedural compliance, on surveillance and monitoring, has put new limits on the people who do work at the sharp end. The emancipation promised by the transformation in safety is now easily held hostage by deference to liability concerns, to protocol, insurance, and fear of regulation and litigation. Rules are put in place and held in place not necessarily because they help create safety, but because they help manage or deflect liability for any bad outcomes. This has spilled over into zero vision commitments as well.

3. MODERNISM AND ZERO VISION

3.1. Optimism and progress toward zero

The modernist vision of work is essentially an optimistic one. The idea of continuous improvement (as driven and monitored by safety bureaucracies) is deeply embedded in the zero-vision of many industries and organizations around the world. Little is

known, however, about the exact activities and mechanisms that lie underneath the reductions in harm that committed companies have witnessed, and little research has been conducted into this (Zwetsloot et al., 2013).

3.2. Manipulating the dependent variable

One important reason for this is that the goal, the zero vision, is defined by its dependent variable, not its manipulated variables. Safety is always the dependent variable—it is influenced by a lot of other things (the independent or manipulated variables). Increases in production pressure and resource shortages (independent variables), for example, can push the operating state closer to the marginal boundary, leading to a reduction in safety margins (the dependent variable) (Rasmussen, 1997). A decrease in the transparency of interactions and interconnections (the independent variable) can increase the likelihood of a systems accident (the dependent variable) (Perrow, 1984). Structural secrecy and communication failures associated with bureaucratic organization (independent variables) can drive the accumulation of unnoticed safety problems (the dependent variable) (Turner, 1978; Vaughan, 1996). Managerial visibility on work sites (an independent variable) can have an impact on worker procedural compliance rates (the dependent variable).

Zero vision has got this upside-down. It tells managers to manipulate a dependent variable. Zero vision was never driven by safety theory or research. It has grown out of a practical commitment and a faith in its morality. It is a logical continuation, completion even, of the modernist project (Zwetsloot, et al., 2013). Safety theory, after all, is mostly about manipulated variables, even though it often considers which dependent variables to look for (e.g. are incident counts meaningful dependent variables to measure?). But mostly, theories tend to specify the kinds of things that engineers, experts, managers, directors, supervisors and workers need to do to organize work, communicate about it, write standards for it. What they need to manipulate, in other words. Outcomes (measured in terms of incidents or accidents, or in terms of indicators of resilience) then are what they are. In retrospect (and the study of past accidents is often what drives theorizing on safety), outcomes can be traced back to manipulated variables (whether validly or not). Zero vision turns all of this on its head. Managers are expected to manipulate a dependent variable—a complete oxymoron. Manipulating a dependent variable is something that science considers to be either experimentally impossible or professionally unethical. And that is what zero vision can inflict as well. With a focus on the dependent variable—in terms of how bonuses are paid, contracts are awarded, promotions are earned—fraudulent manipulation of the dependent variable (which is, after all, a variable that literally depends on a lot of things not under one's control) becomes a logical response.

3.3. Bureaucratic entrepreneurialism

Not surprisingly, there is no evidence that zero vision has an impact on safety that is any greater than the next safety intervention (Donaldson, 2013). This may

not matter, however, as zero visions are a strong instrument of what is known as bureaucratic entrepreneurialism. It allows people involved in safety to say two things simultaneously: they can claim that great things have been accomplished already because of their work, but that more work is necessary because zero has not yet been reached. And because it never will, or because the organizational fear of backsliding away from zero can be maintained, safety people will stay relevant, employed, contracted, funded. Whether people in these positions genuinely believe that injuries and accidents can be fully expunged is hard to know. But they have to be seen to believe it—in order to attract investments, work, federal grants, contracts, regulatory approval, and affordable insurance.

3.4. Cynicism, stigmatization and suppression of bad news

Does a zero vision have practical benefits? Defining a goal by its dependent variable tends to leave organizations in the dark about what to do (which variables to manipulate) to get to that goal. Workers, too, can become sceptical about zero sloganeering without evidence of tangible change in local resources or practices. It is easily seen as leadership double-speak (Dörner, 1989). A recent survey of 16,000 workers revealed wide-spread cynicism in the face of zero vision (Donaldson, 2013). Not only is it unable to practically engage workers, there is nothing actionable (no manipulable variables) in a mere call to zero that they can identify and work with. A zero vision also tends to stigmatize workers involved in an incident. One of the most deeply rooted instances of this can be found in medicine, where many are still battling the very idea that errors don't occur (Vincent, 2006). Many in that world are faced daily with a world where errors are considered to be shameful lapses, moral failures or failures of character in a practice that should aim to be perfect (Bosk, 2003; Cook & Nemeth, 2010). Errors are not seen as the systematic by-product of the complexity and organization and machinery of care, but as caused by human ineptitude (Gawande, 2010); as a result of some people lacking the "strength of character to be virtuous" (Pellegrino, 2004, p. 94). The conviction is that if we all pay attention and apply our human reasoning, we too can make the world a better place (Gawande, 2008). The 2000 Institute of Medicine report (IOM, 2003) was accompanied by a political call to action to obtain a 50% reduction in medical mistakes over five years. This was not quite a zero-vision, but halfway there. It may have either confirmed, or exacerbated, in medicine and elsewhere, the feelings of shame and guilt when failures do happen, and helped to drive underreporting, fudged numbers and stifled learning (Dekker, 2012, 2013). Indeed, zero vision can lead to a suppression of evidence about incidents, injuries or other safety issues, as well as to the numerical gymnastics and re-labelling that happens in the reclassification of worker injuries by companies, insurers and medical personnel. The unethical behaviour it can incentivize might sometimes even be judged as illegal, or criminal:

A Louisiana man is spending time in prison for lying about worker injuries at Tennessee Valley Authority nuclear facilities, which allowed

his company to collect \$2,5 million in safety bonuses. A federal court news release says that the 55-year old was sentenced to serve 6,5 years in prison followed by two years of supervised release.

He was the safety manager for the Shaw Group, a construction contractor. He was convicted in November of not reporting injuries at the Sequoyah and Watts Bar plants in Tennessee and Brown's Ferry in Alabama between 2004 and 2006. At his federal trial, jurors heard evidence of more than 80 injuries that were not promptly recorded, including broken bones, torn ligaments, hernias, lacerations and injuries to shoulders, backs and knees. Shaw Group paid back double the bonuses (Anon., 2013).

3.5. Spending investigative resources

Investigative resources are easily wasted too: if zero is assumed to be achievable, then everything is preventable. And if everything is preventable, everything needs to be investigated, including minor sprains and paper-cuts. And if an organization doesn't investigate, it can even have direct legal implications. A documented organizational commitment to zero harm can lead a prosecutor to claim that if the organization and its managers and directors really believed that all harm was preventable, then such prevention was reasonable practicable (Donaldson, 2013). They are liable if harm occurs after all, since they or their workers must have failed to take all reasonably practicable steps to prevent it. Judith Green has tracked this evolution in our thinking about accidents (Green, 2003), and it is not hard to link it to a global trend toward the criminalization of mistake (Dekker, 2011). As one of the by-products of modernism, our interpretation of accidents has shifted dramatically. Startling failures such as the Three Mile Island nuclear accident in 1973 and the collision of two jumbo jets at Tenerife in 1977 are no longer seen as meaningless, uncontrollable, random events. On the contrary, the promise of modernism is progress, control (Beck, 1992). And accidents are evidence that such control was lost; that a particular risk was not managed well enough. Accidents are not evidence of uncontrollable events, but evidence of uncontrolled events. Such failures of risk management open the door for us to look for somebody who was responsible. If misfortune hits today, we really don't see it as random or uncontrollable any longer. We often want to find out who didn't do her or his job. And then we want to put the "accident" on their account (Dekker, 2012).

4. ARE ACCIDENT-FREE ORGANIZATIONS POSSIBLE?

A zero vision is a commitment. It is a modernist commitment, inspired by Enlightenment thinking, that is driven by the moral appeal of not wanting to do harm and making the world a better place. It is also driven by the modernist belief that progress is always possible, that we can continually improve, always make things better. Past successes of modernism are taken as a reason for such confidence in progress. After all, it has

helped us achieve remarkable increases in life expectancy and reduce all kinds of injuries and illnesses. With even more of the same efforts and commitments, we should be able to achieve more of the same results, ever better. But a commitment should never be mistaken for a statistical probability. The statistical probability of failure in a complex, resource-constrained world—both empirically, and in terms of the predictions made by the theory—simply rules out zero. In fact, safety theorizing of almost any pedigree is too pessimistic to allow for an incident- and accident-free organization.

Look at man-made disaster theory, for example. On the basis of empirical research on a number of high-visibility disasters, it has concluded that "despite the best intentions of all involved, the objective of safely operating technological systems could be subverted by some very familiar and 'normal' processes of organizational life" (Pidgeon & O'Leary, 2000, p. 16). Such "subversion" occurs through usual organizational phenomena such as information not being fully appreciated, information not correctly assembled, or information conflicting with prior understandings of risk. Turner noted that people were prone to discount, neglect or not take into discussion relevant information. So no matter what vision managers, directors, workers or other organization members commit to, there will always be erroneous assumptions and misunderstandings, rigidities of human belief and perception, disregard of complaints or warning signals from outsiders and a reluctance to imagine worst outcomes—as the normal products of bureaucratically organizing work (Turner, 1978).

Not much later, Perrow suggested that accident risk is a structural property of the systems we operate (Perrow, 1984). The extent of their interactive complexity and coupling is directly related to the possibility of a systems accident. Interactive complexity makes it difficult for humans to trace and understand how failures propagate, proliferate and interact, and tight coupling means that the effects of single failures reverberate through a system—sometimes so rapidly or on such a massive scale that intervention is impossible, too late, or futile. The only way to achieve a zero vision in such a system is to dismantle it, and not use it altogether. Which is what Perrow essentially recommended societies do with nuclear power generation. Some would argue that Perrow's prediction has not been borne out quantitatively since the theory was first publicized in 1984. Perrow's epitome of extremely complex and highly coupled systems—nuclear power generation—has produced only a few accidents, for example. Yet the 2011 earthquake-related disaster at Fukushima closely followed a Perrowian script. The resulting tsunami flooded low-lying rooms at the Japanese nuclear plant, which contained its emergency generators. This cut power to the coolant water pumps, resulting in reactor overheating and hydrogen-air chemical explosions and the spread of radiation.

Vaughan's analysis of the 1986 Space Shuttle Challenger launch decision reified what is known as the banality-of-accidents thesis (Vaughan, 1996). Similar to man-

made disaster theory, it says that the potential for having an accident grows as a normal by-product of doing business under normal pressures of resource scarcity and competition. Telling people not to have incidents or accidents, to try to get them to behave in ways that make having one less likely, is not a very promising remedy. The potential for mistake and disaster is socially organized: it comes from the very structures and processes that organizations implement to make them less likely. Through cultures of production, through the structural secrecy associated with bureaucratic organizations, and a gradual acceptance of risk as bad consequences are kept at bay, the potential for an accident actually grows underneath the very activities an organization engages in to model risk and get it under control. Even high-reliability organization (HRO) theory is so ambitious in its requirements for leadership and organizational design that a reduction of accidents to zero is all but out of reach. Leadership safety objectives, maintenance of relatively closed operational systems, functional decentralization, the creation of a safety culture, redundancy of equipment and personnel, and systematic learning are all on the required menu for achieving HRO status (Rochlin, LaPorte, & Roberts, 1987). While some organizations may hew more closely to some of these ideals than others, there is none that has closed the gap perfectly, and there are no guarantees that manipulating these attributes will keep an organization at zero (Sagan, 1993).

5. BEYOND ZERO VISION

It is perhaps time, yet again, for a new era in how we consider the role of human beings in the creation of work safety; time to think beyond zero. Of course, we should not discontinue what we are doing all at once, and some things we should not ever discontinue. These have, after all, led to significant reductions in harm and damage. But we should not have the expectation that they will help us do much more than maintaining current levels of safety in many industries. Getting beyond zero will take a long time and a significant cultural transition, for sure. It will hinge on a number of key transitions:

- We need to transition from seeing people as a problem to control, to seeing people as a solution to harness;
- We need to transition from seeing safety as a bureaucratic accountability *up*, to seeing it as an ethical responsibility *down*;
- We need to transition from seeing safety as an absence of negatives to seeing it as the presence of a positive capacity to make things go right.

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HOW DO EXPERTS AND NOVICES EVALUATE EVIDENCE IN EMPLOYMENT DISPUTES?

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1.1 INTRODUCTION

A study was conducted to explore the process by which experts form judgments about labour disputes. The Naturalistic Decision Making (NDM) literature suggests people use mental models when making decisions. Legal literature suggests people should reason probabilistically when evaluating evidence. This study will combine these approaches, investigating how experts use mental models to reason probabilistically. Johnson-Laird's et al. (1999) mental model theory (MMT) of probabilistic reasoning will be applied to labour cases to test how well it explains expert decisions in this domain.

1.2 The Decision Context

This study investigates how decisions are made by labour officers, who under the Employment Act (Act 265) are required to evaluate evidence in employment disputes. Employment disputes are defined as the failure of employers or employees to fulfil the provisions and requirements under the Act or its regulations applied at the Department of Labour in Peninsular Malaysia. For the purpose of this study, the employment disputes refer to labour cases under the Employment Act 1955 which involve monetary claims by workers against the employers or the employers against workers. The Labour Court acts as a mechanism to conciliate or settle the disagreement above. Consistent with the department's target, every labour case needs to be settled within three months from the date the case was filed. For example, the labour officers as presiding officers are obliged to investigate and analyse all

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